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SCIENCE

3 January 1958
Volume 127, Number 3288

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The place of the Particle Accelerator in Basic Research...

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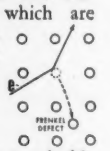
Ernest Rutherford —1927

High-energy Electrons in Solid-state Physics—I

Studies of radiation effects are vital to physicists in developing the theory of the solid state. For example: high-energy particles have been used extensively to produce defects in crystalline materials. The resulting vacancy-interstitial pair alters the mobility of the charge carriers, and therefore the electrical characteristics of the material. In conductors, this will result in decreased conductivity. In semi-conductors, the defects, which are primarily of the Frenkel type, will act as carrier traps and decrease the carrier lifetime. A knowledge of these effects which can be easily measured has been invaluable in extending the theory of crystal structure.



Lattice Bonds

Theoretical studies in ionic and co-valent crystals have shown that the lattice binding energy is about 25 ev. The energy of an electron which can cause a single displacement is therefore of the order of 0.4 Mev. This figure is confirmed by a number of experiments with electrons from Van de Graaff accelerators. Reports of these experiments have come from Purdue University using the University of Notre Dame accelerator[1], North American Aviation, Inc.[2], Bell Telephone Laboratories[3], and others. All confirm the theory within the experimental errors. More refined measurements on such aspects as crystal orientation by Bell Laboratories[3], and minority carrier lifetime, by R.C.A. Laboratories[4], are under way and will serve to extend even further our understanding of the crystal structure.

Type of Particle

Many different particles can be used for radiation studies. Their effects differ mainly in the momentum transferred to the lattice atom. Heavy particles transfer a large amount of energy. The ejected atom may have enough kinetic energy to cause subsequent displacements and produce a thermal spike in which a large number of atoms are involved. This type of damage is hard to analyze because of its complexity.

Light particles, such as electrons, can be accelerated to energies where only a single displacement will occur. It is possible to measure the binding energy of the atom in the lattice by suitable measurements following this type of bombardment.

The source of these particles can be an accelerator or a nuclear pile. The need for precise control of certain variables and the necessity for knowing the particle energy makes the accelerator a superior source. The Van de Graaff has been used extensively in these studies because its precision and energy stability best meet the requirements.

Applications

Studies of radiation effects can be applied to current problems. Nuclear pile designers must know how much radiation a material can withstand before failure, and how well important instruments will stand up under particle bombardment. In particular, sensitive electronic systems must operate safely in high-intensity radiation fields. This is particularly true for nuclear-powered aircraft and guided missiles. Much work is now going on in testing components in radiation fields provided by particle accelerators.

There have been reports of high-frequency diodes being produced by irradiating semi-conductor materials to reduce the carrier lifetimes. While these have not been produced commercially, it appears that this is a simple method of producing traps in semi-conductors where they are needed.

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[1]E. E. Klontz, K Lark-Horowitz, Phys. Rev. 86, 643, 1952
[2]D. T. Eggen, M. J. Laubenstein, Phys. Rev. 91, 238, 1953
[3]W. L. Brown, Bull. APS, 2, 156, 1957
[4]P. Rappaport, Phys. Rev. 94, 1409, 1954

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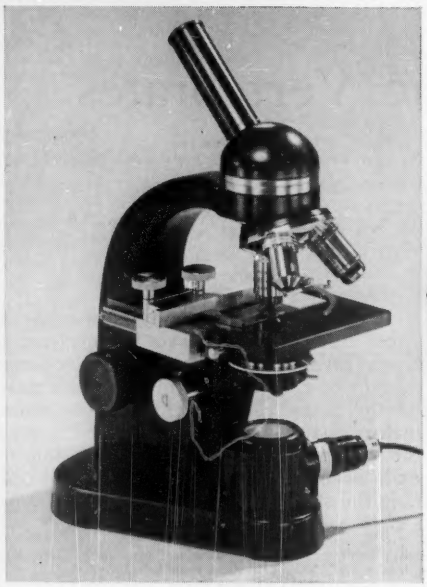

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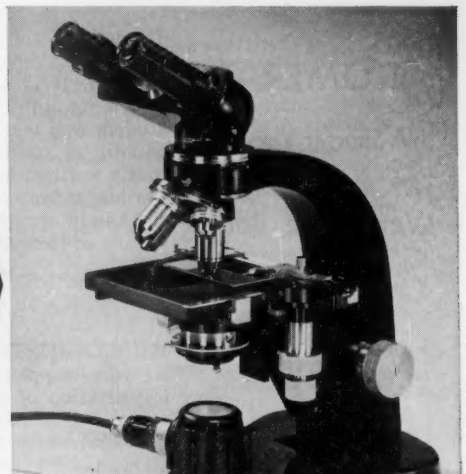

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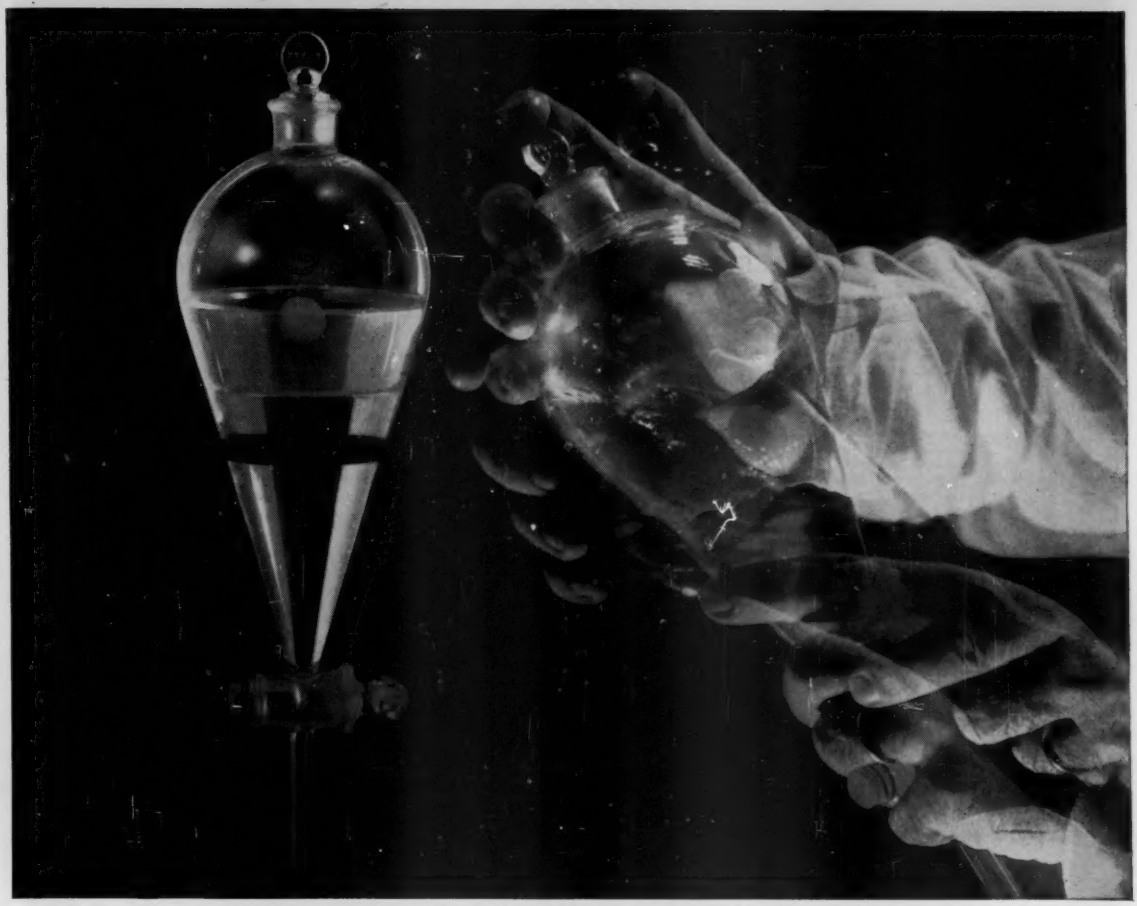

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SCIENCE is indexed in the *Reader's Guide to Periodical Literature* and in the *Industrial Arts Index*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see *Science* 125, 16 (4 Jan. 1957).

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To Our Readers

The decision to combine *The Scientific Monthly* with *Science* and to continue the joint journal in the *Science* format was made with the expectation that the combined journal would be more comprehensive, interesting, and useful than either by itself.

In this first issue following the fusion we should like to outline our expectations and policies. The section devoted to lead articles will be enlarged to permit publication of articles of the type formerly published in the *Monthly*. We expect the lead articles to range over a wide field and to include articles on the history and philosophy of science, on the technical and social problems in the applications of science, and on the reciprocal relations between science and government, between science and international affairs, and between science and education.

In addition, we will continue to publish articles, such as those that often appeared in the *Monthly*, on the state of knowledge in the various divisions of science. In this connection we have planned a new series of articles on *Current Problems in Research*. For inclusion in this series we will select subjects from the physical, the biological, and the social and behavioral sciences. Among the topics planned for the series are the following: age of the universe, air pollution, astrophysics, atmospheres of other planets, chemistry at high pressures, earthquakes and the earth's crust, economic cycles, human archeology, human evolution, the ionosphere, superconductivity, viruses and nucleoproteins, musical acoustics, scientific manpower, meteorology and forecasting, and so on.

The articles in the new series, although written by specialists, will be designed to bring the reader up to date in fields other than his own; they will be directed to the scientifically literate public rather than to the specialists in the field; and they will be as clearly written and as free from technical detail as is consistent with adequate presentation.

The news section will continue to record events of interest to the scientific community and will expand its treatment of pending legislation of concern to science, the role of scientists in government, and international events of scientific interest.

The book review section will be enlarged by virtue of the fact that in the future all books deemed worthy of review will appear in the combined journal rather than in one or the other.

For the rest, we expect to maintain the other sections of *Science* at the present level, except for a possible expansion in the section devoted to reports.

One unusual and widely misunderstood policy merits explanation. The American Association for the Advancement of Science, even though it owns and publishes this magazine, does not expect the editor to give preference in publication to members or fellows of the Association. This policy is also extended to official addresses and is the same as it was when Willard L. Valentine, the first editor of *Science* after the Association acquired full ownership, said in an editorial (4 January 1946), "Wisely, the Executive Committee refused to bind the Editor's hands, so that *Science* is not *required* to publish all official addresses."

These are our plans and policies. From time to time we will make other changes. Let us know your reactions. The suggestion box is always open.
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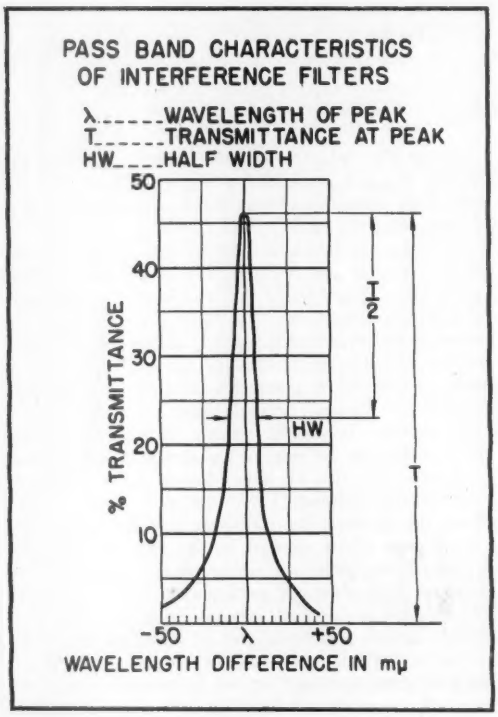

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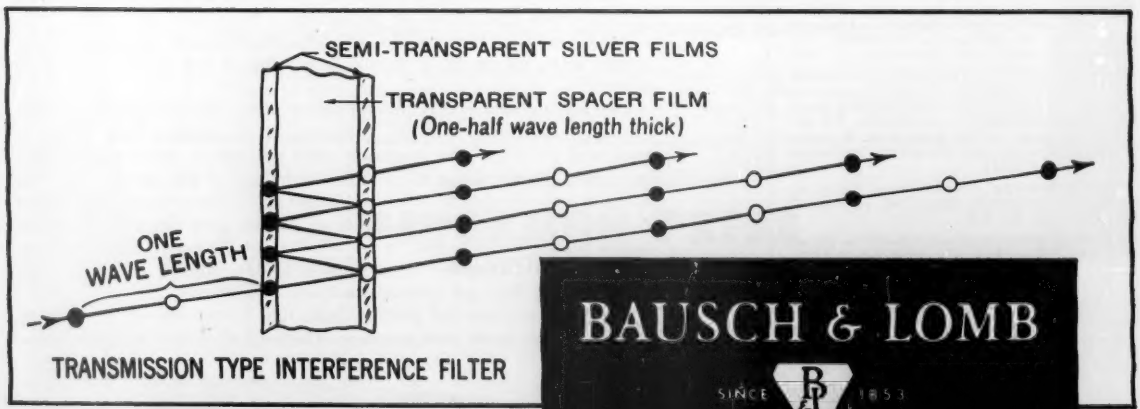

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The Inexorable Problem of Space

Paul B. Sears

Discovery and communication are the two prime obligations of the scientist. On occasions such as this, however, the scientist has the added opportunity to examine broad issues in the light of his peculiar knowledge and experience. This I propose to do with respect to that limited segment of space in which we live, move, and have our being. For my subject was chosen long before man's most recent and dramatic invasion of outer space.

Science and Perspective

My thesis is that, among the practical problems of humanity today, our relation to immediate space is of critical importance. In developing this idea, I shall try to show that our applications of science have been both restricted and shortsighted. In terms of moral choice, we have looked upon science as an expedient rather than as a source of enlightenment.

To be specific, our very proper concern with the applications of mathematics, physics, and chemistry may be clouding the fact that we need biology in general and ecology in particular to illuminate man's relation to his environment. At present the biological sciences are largely sustained as utilities in medicine and agriculture, the social sciences for dealing with immediate ills. But we must not forget that all science is needed to guide the process of future evolution —cultural and physical—now so largely in our own hands. The nest of anti-intellectualism is being warmed by the ignorant, but some of the eggs in it may have been placed there by those who should know better.

Science and Policy

I have no quarrel with the exploration of outer space. It is a legitimate and challenging subject for scientific inquiry and bold experiment. Our optical and mathematical studies of it have long since given us that basic confidence in order without which there could be no science. But, as we extend our astronomy by whatever celestial acrobatics we can get away with, I should like to see some consideration given to relative values. We have a vast amount of unfinished business at our feet. The golden moment for the pickpocket comes when everyone at the county fair is craning his neck at the balloon ascension.

So far as the skies are concerned, we are feeling the natural soreness that comes from losing a sporting event we thought was in the bag. Actually, if my information is correct, the Russians had explained that they intended to launch a satellite, had indicated its probable size, and have promised to share the knowledge so gained. Since any ray of light should be welcomed in an atmosphere of gloom, it may help to recall that our Olympic athletes, in the face of leading questions from their interviewers, had nothing but respect to offer for the conduct of their Russian rivals.

Of course our present concern is much more than simple chagrin at losing a contest. What has happened in outer space raises a question about how outer space will be allocated and controlled. We fear, not unreasonably, that whoever controls the space around the earth can impose his will upon all who live on the earth's surface.

Though we grant freely the military significance of space experiments, our present hysteria seems to me to indicate an even deeper source of insecurity. We are beginning to sense that the elaborate technology to which we are so thoroughly committed makes us peculiarly vulnerable. And we are not wholly confident that the ideals of our civilization —so reasonable to us—will really stand up to free competition with other systems of thought. To the extent that this is true, we suffer from an initial handicap of morale.

The pattern of conflict is much the same, regardless of scale. Whether one is watching small boys in the school yard or great powers in the world arena, the preliminaries are marked by bad manners and vituperation on both sides. Missiles are piled up and seconds are assembled, the advantage going to the cooler, less hysterical side. The contestant who gets rattled is asking for trouble.

I do not envy our public servants charged with the delicate business of managing international relations. But I am firmly convinced that unless one is determined on war, there is merit in self-restraint and good manners, as well as in prudent measures of self-protection. I am also convinced that the choice of policy is not limited to boasting and belligerence on the one hand or craven appeasement on the other. We have no monopoly on self-respect and other human virtues, nor is there any merit in debasing the original meaning of the word *compromise* as we have done. We should deplore every display, whether by statesman or journalist, of dunghill courage that lessens the hope of mutual understanding, good-will, and ultimate collaboration among human beings.

Dr. Sears, retiring president of the AAAS, is chairman of the Conservation Program at Yale University, New Haven, Conn. This article is based on his AAAS presidential address, which was given 28 December 1957, during the Indianapolis meeting.

So far as purely domestic problems go, our almost hypnotic concern with outer space comes at a bad time. Outer space is one more item that diverts attention and energy from the prosaic business of setting our terrestrial space in order. And it has fostered an incredible type of escapism that must be experienced to be believed. One hears too frequently for comfort the sober assertion that we need not worry about depletion of natural resources, now that interplanetary travel is just around the corner! If such a comment came from jesters or cranks, it could be disregarded. But we hear it uttered with the solemnity and assurance of the true believer. No doubt we shall continue to hear it, despite the chilling analysis by Arthur Clarke, the British astronomer, in the November 1957 issue of *Harper's* magazine.

Actually this obsession is not a detached phenomenon. Rather it is the culmination of a new faith—the belief that technology will solve any problems that may confront humanity. Curiously, it comes at a time when the scientist is more suspect than he has been since the days of witchcraft and alchemy, as recent opinion studies show. A high proportion of people consider scientists to be queer fish, if not inhuman and immoral. For a parallel we would have to think of a religion which wants the favor of its gods but does not trust them for a moment.

Opportunistic Application of Science

I do not question the tremendous accomplishments and future possibilities of technology. I yield to no one in my admiration for the cleverness, manual and intellectual, of those who apply science to meet the needs of mankind. But faith in technology is not faith in science or sympathy with the creative impulse of the scientist. The direction in which science is applied depends upon the values of the culture applying it even while science is in turn modifying the culture.

Our present applications of science are selective and opportunistic, neither wholehearted nor balanced. We are applying it out of all proportion to the elaboration of consumer goods, often to such an extent that vast sums must go into persuading people to desire what they have not instinctively wanted. The making of things has become so facile that their sale creates major problems in advertising and credit. As Max Beerbohm once put it, "Buy advertised goods and help pay the cost of advertising." Some of the keenest satire on advertising has come from advertising men themselves. Raymond Loewy, the famous automobile designer, has protested the corruption in car design that has resulted from too great facility—traditionally the death of any sound art. The current models waste space, materials, and fuel, violate good taste, and impose needless economic burdens on the public. And while we are applying science in this manner, we are blandly ignoring its highest function, which is to give us perspective and inform us about what we are doing to ourselves. Even the scientist, as Kubie has so ably shown, suffers from his lack of self-analysis.

On the whole, a man's actions are a response to his idea of the kind of world he thinks he is living in and to his concept of his own nature. That this is true is shown very practically in the history of human thought: No great religion is content merely to lay down maxims of conduct; it also develops its own cosmogony, its own pattern of the universe, to justify those maxims.

Our present attitude toward terrestrial space exemplifies with peculiar clarity our selective use of science. For living space, if we consider both its extent and quality, subsumes all other resources, being in that respect equivalent to the economist's technical concept of land. Yet the power of applied science has been overwhelmingly employed to exploit space, while those aspects of science which could illuminate its wise and lasting use are still largely ignored.

I am assuming at the outset that the human adventure on this planet is worth our best efforts to keep it going as long as possible. I am also assuming that man is capable of responsible judgment and conduct and that he has at hand much of the important basic information he needs. Finally, I am assuming that it is not enough for man to live by bread alone but that intangible, as well as tangible values are necessary to justify his persistence. If this be true, the question is, not how many people can exist on earth, but what kind of a life will be possible for those who do.

Limiting Factors

From New Jersey to Oregon one sees great egg factories, where highly selected strains of poultry are confined at maximum density and with maximum efficiency. Every need—nutritive, environmental, and psychological—is taken care of. These gentle, stupid birds have no responsibility but to stay alive and do their stuff. Yet they are at the mercy of any break in an elaborate technological mesh that keeps them going. And should a stranger burst abruptly into their quarters, the ensuing panic would pile them up in smothering heaps in the far corners of their ultramodern apartment. The underprivileged, pretechnological hen ran many hazards, but at least she had the freedom to scratch around for food and a sporting chance to dodge under a bush to evade the swooping hawk.

People, of course, are not poultry, but they are living organisms, subject to the limitations inherent in that condition. I am unmoved by any protest against applying biological analogies to human society. Analogy is one of the most powerful tools of the scientist. From physics to physiology, and notably in the latter, analogies suggest our models which we must then test and either accept or reject as the evidence may dictate. And besides, man is a living organism, as I have said.

Fortunately, in considering man's relation to terrestrial space, our models do not all come from observing other forms of life. We have some impressive ones furnished by our own species. Let us reserve them, however, for the present, and look at the other living things. Here from students of bacteria, trees, insects, or any of the sundry groups of vertebrate animals—fish, fowl, or mammal—we get the same story. No known form of life has been observed to multiply indefinitely without bumping up against the limitations imposed by the space it occupies. These limitations involve not only quantity but quality. And quality rests upon the pattern of that complex of factors, whether known or unknown, that are necessary to sustain the species in question. So far as environment is concerned, an ancient bit of wisdom sums up the situation: "A chain is no stronger than its weakest link."

This principle was recognized by Liebig in his famous law of the minimum: the growth of a crop is determined by the essential nutrient available in least quantity. It was restated more precisely by Blackman in his law of limiting factors: physiological processes are limited by the least favorable factor in the system of essential conditions. These statements rest upon controlled experiment. They are independent of the circumstance that an English political economist and parson, Malthus by name, had suggested that human populations did not, in fact, increase indefinitely beyond certain limitations of environment.

It should be emphasized, however, that the writings of Malthus did give the necessary clue that enabled Charles Darwin to formulate a reasonable explanation of the mechanism involved in the origin of species. Since there remain many misconceptions with regard to both Malthus and Darwin, it may be well to review the thesis of the latter. This thesis has never been successfully controverted, although there are perennial headlines "Darwin Refuted" whenever some detail of his work is brought into question. Briefly, Darwin had noted the universal tendency of organisms to vary and to transmit these variations to their offspring. Our knowledge with respect to these matters is now being applied daily by plant and animal breeders with the same effectiveness with which the phase rule is used in chemical engineering.

Darwin's second point was that organisms tend to reproduce far beyond their capacity to survive. This again in fact occurs, and is a matter of household knowledge among those who, as scientists, observe living organisms. The tagging of fish that return to the place where they began migration reveals that, despite the thousands of eggs laid by each female, not more than a few adults from each batch survive to make the return journey.

Anyone who has observed, year after year, the nesting of robins in his yard has noted the consistent toll—from cats, jays, crows, and accidents—that serves to keep numbers down. And though the clutch of eggs is fairly uniform from year to year—implying a potential doubling of the robin population—the number of nests does not increase significantly, nor do these birds spread beyond a well-defined territorial range. Even though predators might fail to control their numbers, competition within the species would establish a threshold of limitation, as it did for deer when wolves were eliminated.

The final point made by Darwin was that the relatively small proportion of individuals surviving did so, not merely by random chance, but largely because they were those best fitted to cope with their environment. The less favorably endowed tended to be eliminated. Thus the better adapted lived to transmit their favorable variations. In this way he accounted for two great riddles of living nature—the immense variety of living things and the remarkable adjustments they show.

It is not my object here to justify Darwinian theory. It is enough to say that the theory coordinates more information than any alternative that has been proposed. This is all we have a right to ask in science. We need emphasize only one corollary—that the pattern of environment is built solidly into that of life. Survival rests upon this relationship. No organism known to biologists has ever, so to speak, had things completely its own way. Some, of course, are more "successful" than others, as the late L. O. Howard indicated in his famous dictum that the last survivor on earth would be a living insect on a dead weed.

Extension to Man

The rub comes when we attempt to extend these principles to our own species. As life has advanced from simple beginnings, it has played an increasing role in geological processes. Man is no exception. He is a world-wide dominant, the first such species in earth history. And through advancing technology he is producing tremendous changes. That this should confer a sense of power is understandable. But power is not the same thing as control. Only when power is balanced by responsibility is there control, as the record of our highway accidents attests. The corrupting effect of irresponsible power is an axiom in human history.

Is there any reason to believe that man is exempt from the rules that apply to living organisms in general? Or does the difference lie in his ability to learn those rules and profit by respecting them? Can we make use of known physical and biological principles in discussing problems that involve man? Can we view psychological and sociological considerations in the light of simpler and more obvious ones, or must we rely solely upon a higher level of discourse when we speak of man? These are not idle questions. I have mentioned the indignant protests against applying "biological analogies" to sociological problems. But it is one thing to hold that man is *merely* a physicochemical system, or *merely* an animal, and quite another to insist, as I must, that he is a physical phenomenon, and a biological one too, whatever else he may be.

Man's physical body occupies space, somewhere between two and four cubic feet of it. At his present rate of increase in the United States, he is set to double the aggregate volume occupied by human bodies in about 41 years. Continuing at this rate, it would be less than 700 years—say 22 generations—until there is standing room only, with each space of 3 by 2 feet, or 6 square feet, occupied. On this basis there is room for exactly 4,646,400 people in each square mile. I have perhaps been overgenerous in estimating the per capita area, but I did wish to leave space enough to permit each individual to reach in his pocket for the rent money when it falls due. A little after this the hypothetical human population would weigh more than the planet.

In thus giving rein to imagination I have in mind sundry pronouncements regarding the potential capacity of the earth, some of them to the effect that by proper scientific management it can take care of any conceivable increase in population. The numbers I have mentioned are both conceivable and begettable. The question is, are they supportable?

Some Examples

The most densely populated continent is Europe, with 142 people per square mile, as against Asia with 78, although the most densely populated areas are as yet on that continent. Australia follows with 31, then North America, including great areas of desert and tundra, with 23, while Africa and South America are nearly tied, with 17 and 16, respectively. The figure for the United States is 51, intermediate between that of Australia and Asia. Evidently cold fact, as so often happens, has not kept pace with theory. Either people do not breed as fast as they might, or survival rates are not what they could be. Actually both of these things happen, and in curious combinations. We may, I think, allow the battered bones of the Reverend Malthus to rest in peace as we examine a few case histories quite briefly.

First, however, let us retrace our steps for a glimpse at what we pleasantly call the lower orders of life. Abstracting an item from the valuable studies of Thomas Park, we learn that when populations of flour beetles reach certain densities, their rates of increase drop sharply. Among other things, these animals begin to eat their own eggs and pupae, a very effective way of slowing down the operation of the compound interest law. Whether this practice is due to a craving for food and water or simply to the fact that hungry beetles bump into eggs oftener than before, we do not know.

The lemmings in Alaska are likewise instructive. These small rodents, living and breeding under the snow, have a kind of pulsating population record,

abundance alternating with low density in fairly regular fashion. With summer melting, they are preyed upon by a variety of animals, including the Arctic fox and snowy owl. A third predator, the jaeger, a kind of sea hawk somewhat resembling a gull, has been studied by Frank Pitelka, who reported on it at the Berkeley meeting of the AAAS. When the lemming population is low or average, the jaegers space their nests and consume their prey in an orderly manner. But when the lemmings are at a peak, so that food should be no problem, the jaegers spend so much energy quarreling over nesting space and food that relatively few of them raise normal broods. So their numbers decline, but not primarily from lack of food. They do not urbanize well—or shall we say that when they attempt to urbanize they pay the usual penalty of a greatly lowered reproductive efficiency? For it is, I believe, an open secret that few cities of major size have heretofore maintained their population by their own birth rate—a situation that is probably changing through the rapid development of suburban life. Perhaps it is time for some modern Aesop to instruct us on manners and morals, using for that purpose the verified behavior of animals instead of their imagined words. Certainly we learn that for the jaegers plenty is not an inevitable road to biological success.

Yet the idea of plenty—in food in particular, in energy and minerals to a lesser degree—dominates the discussion by scientists of man's future. Some of this material is excellent, notably that by Harrison Brown, who not only understands the physical sciences but has biological sense and a conscience to boot. Too few, however, bother to read the fine print and observe the *if*'s in such analyses as his. Those who, like Osborn, Cook, Sax, and Vogt, concern themselves with space and numbers are written off as "pessimists," as though the fixing of a label adjudicates the issue and solves the problem.

It is the merit of the men named, including Brown, that they have raised not only a material but a moral issue that is too often neglected by those who proudly label themselves "optimists." The question is not only how much but what kind of life will be possible if humanity continues to hurtle along its present course. Russell, the Huxleys, and Berrill have all warned us of the inevitable loss of freedom and personal dignity that must follow the multiplication of numbers and the depletion of resources.

Physical Limitations and Cultural Influences

The findings of archeology are in agreement with recorded observations of prefarming cultures about the space requirements of hunters, fishers, and gatherers. For such folk the space requirements are great, by modern standards, being no less than three to five square miles per person where conditions are most favorable. The best estimates for pre-Columbian United States, even with such agriculture as it possessed, do not reach three million in about the same number of square miles. Specifically, the state of Ohio, some 40,000 square miles, mostly fertile and well-watered, does not appear to have supported more than about 15,000 Indians at the time of European discovery. Even the Basin of Mexico, with a highly efficient system of horticulture and an imposing array of domesticated plants, did not have numbers exceeding a million—one-third the population of the present Mexico City, which occupies only a fraction of the modern basin.

Yet we know that this rather moderately concentrated population experienced pressures of various kinds during the centuries preceding 1519. However the situation might be rationalized, the limitations of space, with regard to both extent and quality, were stern and tangible within the Basin of Mexico. The ancient chronicles are a record of floods, drouths, volcanism, and hunger. Toward the end of the Aztec Empire, in a desperate attempt to placate the angry gods, human sacrifice was stepped up until it reached scores of thousands—suggesting the rate of emigration that today serves to stabilize the population of Ireland, whose chief export is people.

Our judgment of the whole history of agriculture has been revamped since the 1930's. Dale and Carter have done this brilliantly, showing that every great center of power and civilization has been based squarely upon fertile space, and tracing the parallel decline of culture and the nutrient capacity of the soil.

Certainly human communities have, as a matter of record, more than once run hard into the physical limitations of their environment. Often they have intensified these limitations by their own activities. That man can preserve and even enhance the potential of his environment, I do not question. But I see no warrant for asserting that he has often done it or can do so indefinitely under his present pattern of behavior.

Limiting factors are not necessarily physical in the strict sense. Cultural disruption and spiritual discouragement may likewise act as restraints. This is believed to explain the well-known decrease of the native Indian population during the century following the Spanish conquest of Mexico. With little to live for, people may simply not have families, whatever the physiological facts and urges may be. Another instance is that of the slave population in Jamaica prior to 1842. The white population, numbering less than one-tenth that of the slaves, vigorously discouraged breeding among the slaves, since it was cheaper to buy new slaves than to propagate them. Nevertheless, the apathy toward life, attested by the high suicide rate among victims of the slave trade, is believed by competent authority to have been an important factor in the low effective reproduction rate among these pathetic humans.

If we come closer home, we have the significant drop in family size during our own depression of the 1930's. In this instance, the slow-down cannot be attributed to pressure from the physical environment, for the depression preceded the great drouth. Even then there was no real scarcity of food, merely a breakdown in the mechanism for its economic distribution. Presumably the direct pressure came from cultural anxiety, or what is sometimes called "social shock." Even the "recession" of 1949–50 produced a measurable effect, total births in 1950 numbering 17,000 less than in 1949.

We have, too, the earlier decrease in the British birthrate about 1921. This was the year in which Marie Stopes, already famous as a paleobotanist, enlightened the public on responsible parenthood. It was also a time of high post-war prices, and subsequently a time of flaming individualism. But it was not, so far as I know, a period of physical pressure from environmental forces. Having myself reared a family during the 20's and 30's, I can testify that in our own country there were many cultural pressures, neither physical nor economic, that encouraged one-child or at most two-child families. Not least among these pressures was increasing focus upon the personality and development of the individual child, at times to the point of morbid sentimentality.

Cultural influences can also act in the opposite direction, the classical instance being in the scriptural injunction to be fruitful and multiply and replenish the earth. Today, despite the staggering cost of education and the increasing cost of food—unchecked by our continuing agri-

cultural surplus—the four-child family is in vogue. Incredible though it may sound, it is through the influence of fashion (call it example or prevailing custom if you prefer) that many modern families work out their response to the problem of population and space.

Certainly the record suggests that population density is influenced both by the physical and the cultural environment. However these may operate, either singly or in conjunction, they find expression in the behavior of individuals, and individuals differ greatly. Indeed, one of the most difficult of problems is to sort out the strands—cultural, physiological, intuitive, and rational—that are interwoven into the fabric of individual values and conduct. As Russell has pointed out, and as those who style themselves "human engineers" know only too well, the new psychology has little comfort to offer about the importance of reason in human conduct. This would be especially true among those least capable of using it, yet I, for one, would not give up what confidence we have in it.

Coming now more specifically to the problem of space, we find that the grim facts in certain countries which we euphemistically call "underdeveloped" speak for themselves, as anyone who has visited the Orient, the West Indies, or certain portions of Latin America must honestly admit. Humane and successful efforts to improve health conditions in such areas have, to date, merely intensified the problem, while equally high-minded efforts to improve food production and distribution have only deferred a solution. Ceylon, where disease control has resulted in doubling the population in less than a score of years, is a classical example. Meanwhile, food production has not kept pace, and the usable area of the island has been increased only very slightly through drainage of malarial swamps.

Technological Vulnerability

Perhaps the one bright spot in this gloomy picture is that many of the leaders in these crowded countries are now frankly recognizing the problem and trying, according to their various lights, to face it. But while I would not suggest for a moment that we allow them to stew in their own juice, I do suggest that our own problem deserves more attention than it is getting. The very fact that we have a margin of safety not enjoyed in many parts of the world is both a challenge and an opportunity. Let me recite a few facts, even though they may be familiar.

That the productivity of our agriculture can be increased far beyond the limits of the present surplus is not questioned. But each increment in production calls for increasing capital outlays. The investment in machinery, to say nothing of that in fertilizers, feed supplements, maintenance, taxes, and insurance, frequently approaches the value of the land. The knowledge, skill, and competence of the successful farmer today rivals that tolerated in the practice of medicine fifty years ago. In that interval our farm population has diminished by more than a half, being now less than 20 percent of our total population. The pressure to keep costly machinery earning its way often results in extensive operations at the cost of personal attention to those details which prevent deterioration of the whole enterprise, and which, in the end, may make the difference between profit and loss. So meager is the margin that a significant and growing number of model farms are now owned by industrialists and other people of means to permit legitimate losses on their tax returns. So far as our ultimate food and fiber supply is concerned, we need not expect something for nothing. The late Robert Salter, surely a very conservative individual, pointed out that the high yields from hybrid corn were definitely being obtained at the expense of soil fertility. In the corn belt, yields of 100 bushels per acre are now about one-third as frequent as they once were. My guess is that farm surpluses will be only a memory within two decades.

Alternative methods of production are, of course, being proposed and investigated. Most of these involve increasing dependence upon elaborate technological devices, hence increasing energy, capital, and maintenance costs. Equally serious is the increasing vulnerability that comes from utter dependence upon elaborate technological systems. This can be illustrated by what has occurred when a brave and competent army, trained to rely solely upon mechanical transport, has faced in difficult terrain an enemy hardened to simpler and more primitive methods. It was illustrated by the comparative ease with which the Ozark hill people adjusted to a depression while their highly dependent urban neighbors were thrown completely out of gear for a long period of time.

I forbear to recite what would happen to some of our great urban centers in the event of certain entirely possible technological failures. This is information which ought to be classified if it could be. In October I observed the confusion following a two-hour power failure in the Grand Central area in New York City. Four days later an accident to a single car on the Merritt Parkway in Connecticut delayed traffic for an hour, during which time seven miles of motor cars were halted bumper to bumper. The analogy between extreme urbanites and the denizens of the egg factories mentioned earlier is too close to be comfortable. No doubt the subconscious realization of this accounts to some degree for the difference between our present mood and that of the Turks and Finns. These sturdy people proceed phlegmatically about their simple way of life in spite of their hazardous geographical position.

We too are a brave and peace-loving people. It is entirely possible that we are not so much moved by fear of an enemy as by lack of confidence in the structure of a system in which we are so deeply committed and involved. What I am saying is inspired by those who see in technology the complete answer to the world's problems. For I do not doubt that technology, like a human being, has the defects inherent in its own virtues. If, as I believe, it should be our servant and not our master, its advancement should be in the light of all scientific knowledge and not merely of those facets which are of immediate use. The biologist who attempted to apply his knowledge in defiance of known physical principles would be laughed out of court. Yet we seem singularly trustful of engineering projects carried out in disregard of ecological principles.

The Urban Sprawl

The most obvious and acute pressure upon space is in our great cities and surrounding metropolitan areas, whose existence and expansion depend upon technology. They and the associated industries and highways that connect them are absorbing agricultural land in the United States at the rate of some million acres a year. This means fewer orange and walnut groves in California, dairy farms in Georgia, truck and tobacco land in Connecticut, and less of the proverbially fertile valley land along the Miami in Ohio. All of these instances I have seen, as I have seen 15,000-acre tracts of the best farm land condemned for military installations when less productive sites could have been chosen.

There are some 500 major cities of

over 25,000 population in the United States. Assuming that they could be evenly distributed, and neglecting smaller towns and cities, each would be in the center of a rectangle roughly 80 miles square. I have seen a fair number of them in recent years and recall very few that were not sprawling out into suburbs with little heed to open space, recreation, agriculture, beauty, or even the protection of future values. An exception, as a taxi driver profanely informed me, was not growing because the local university had everything sewed up!

Since this problem of urban sprawl is now receiving intelligent attention in a series of articles in *Fortune* magazine, I shall note only that it is serious, immediate, and far from simple. Municipalities generally have powers of expansion and taxation against which the rural landscape is without defense.

And between cities, across the land, highway departments are busily freezing the nation into a permanent interurban geometry. Often, in fact if not in theory, they are responsible to no one but themselves and their Euclidean rule that the shortest distance between two points is a straight line. Only through leaders who will devise and citizens who will support better use of urban and highway space can growing blight be checked. Professional planners, who, by the way, are seldom summoned until it is too late for them to be of real use, now frankly regard the entire strip from Washington to Boston as one great metropolitan area. Any lingering doubts on this score should fade at the sight of a new throughway blasting its course among rocks and homes, across land and water.

At Washington, southern end of the megalopolitan strip, fateful decisions regarding the future allocation of American space are made. One of the cabinet members who has much to do with such decisions told a recent visitor, "For one individual who, like yourself, comes here to protest the exploitation of wilderness areas, parks, and other public lands, there are a dozen who come here to press the opposing view." No matter what the sympathies of such a public official, these are elementary facts of political life with which he must reckon.

There are, moreover, numerous agencies of government, not always in close harmony, that are charged to administer space and its resources. What happens is the resultant of many forces, including the pressure put upon Congress and the advice it receives from appropriate bureaus.

The late Colonel Greeley used to relate how much of our national forest space was reserved. Congress, alarmed at the rate at which Theodore Roosevelt was setting aside forest reserves, lowered the boom on him, but the law could not become effective until he signed it. During the few weeks of grace Roosevelt, Pinchot, and Greeley spent evenings sprawled on a White House floor with maps, for all the world like kids with a comic supplement, marking out forests while the President still had power to do so.

District of Columbia

Unlike most cities, Washington was built on a definite plan and is still under close supervision. But the unremitting pressure of housing, traffic, and waste-disposal problems is a constant threat to the space required for recreation, let alone for esthetic values, traditionally a matter of concern. Among other things, the Potomac is notoriously polluted, and the pressure for schools and other public facilities in the overflow region outside the district is a headache to all concerned. In these environs, as around growing cities all over the country, one sees a wilderness of houses built to sell. And the buyer is usually more concerned with pushbuttons and gadgets than with sound construction. It takes no prophet to visualize what the condition of these potential slums will be in less than a generation.

New York Area

Not quite midway to Boston is Jersey City and the whole complex of sleeping towns for New York. As of October 25th of this year the authorities of Jersey City were weighing the relative merits of pails versus paper milk bottles to dispense drinking water. The reserve for Jersey City and nearby places was then enough for about one month. Not even that flower of technology, the modern city, is exempt from the pressure of natural forces. Nor should this be surprising. While the per capita demand for water rises, so does the area that is waterproofed and designed to get rid of rain as fast as it falls.

Even the air is a problem. One approaches the Hudson through one of the most unsavory mixtures of gases on earth. What smells bad, with such noble exceptions as Limburger and Liederkranz, is seldom good. New York City, whose canyons full of fumes are no bed of roses, is within the same general zone of turbulence. The resulting uproar reminds one of the classical dispute as to which stank worse, a goat or a tramp.

New York City illustrates what might be called a space paradox. As its population has grown, so has the per capita space, except possibly in some very congested areas. At the same time, the rural areas, whose emigration supplies the growth of nearly all major cities, have fewer people. Farms are increasing in size; fewer men are farming larger farms. Everyone is getting more space while the population rises. The answer is, of course, that the rural man who becomes urban is not getting more space than he had—simply more than he would have had had he moved into the city a generation ago.

New England

Further north, in New England, we encounter other interesting problems of space. Most of them involve conflicts of interest, often elements of minor tragedy. I have in mind the annihilation of homes for which money cannot compensate. One such, whose sturdy hand-made beauty, books, pictures, and furnishings represent the slow accretion of high cultural influence—not mere personal luxury—is now untenable because no better way has been found to dispose of the garbage of an expanding dormitory population than to burn it nearby. In southern Massachusetts I saw the occupants of a group of new homes trying to repair the damage of flood in a site which was notoriously subject to high water. The unwary newcomers who bought these houses did not know this, and no one warned them.

It was, in fact, the floods of 1955 that revealed most dramatically what can happen when important fields of science are neglected while others are being applied to the limit in technological development. Manufacturers of electronic equipment, optical instruments, and precision tools certainly keep abreast of scientific developments. Yet in locating their plants they took risks which no geologist, or competent botanist, would have sanctioned had his opinion been sought. Not only did they expand their activities upon the hazardous flood plain, but in many instances they intruded upon the channel itself, thus making bad matters worse. The old water-mill builders took no such chances. Their homes were on high land, for they knew and respected the power of water.

New England, northern end of the

great metropolitan strip, offers many other examples of the pressure of humanity upon space, although it has no monopoly in this respect. The West Coast, the most rapidly growing area in the nation, may be more graphic, for it lacks any protection from past cultural inertia. But in New England one may see a losing struggle to preserve esthetic and recreational values in the face of an insistent desire to expand industry, cater to the automobile, mine for gravel and rock, convert the rivers into free sewers, and in divers other ways capture the nimble dollar.

In these respects New England is no worse—and no better—than other parts of the nation. Two-thirds of its hinterland are now covered with forest, largely of poor quality, occupying land that was once farmed and later grazed during a booming wool industry. Yet this two-thirds of the area produces not more than ten percent of the rural income. In contrast to this, I know a Danish forest of 2000 acres that furnishes year-round employment to 50 men and 20 additional during the winter months, all at a profit. True, the New England soils are often thin and not highly fertile, but the chief trouble seems to be that we have consistently used up the finest trees, while the Danes since 1800 have been saving them for seed stock. Even though one cannot increase space, proper measures will greatly increase its yield. Inferior races of trees are just as wasteful of space as inferior breeds of livestock on pasture and farm. While New England forests even in their present poor condition add vastly to the beauty of the countryside, the time is not too far distant when their products will be needed. European experience shows that good yield is quite consistent with esthetic value.

Pressures upon Space

Across the continent, with infinite variations due to local conditions, the problem of space is growing in urgency. Ultimately we shall have to face the purely physical fact of increasing numbers on a finite area containing finite resources. Of these resources, water is now getting some of the attention it deserves. But we should keep other substances in mind, recalling that we, with less than 7 percent of the world's population, are now absorbing more than 60 percent of the world's mineral production, or ten times our quota.

Meanwhile, the general pressure is complicated by conflicts of interest. Different groups and individuals see different possibilities in the same area, and all alike wish to secure the most from it. As great cities grow they become more, rather than less, dependent upon widening circles of rural land—for water, milk and other food, transport, recreation, housing, labor, and income. It is interesting to consider the sources of support for the four world territories that have more than 10,000 people to the square mile. They are, in order, Macao, a shipping and commercial center, Monaco, a gambling resort, the District of Columbia, where taxes are collected and spent, and Gibraltar, a military post! No great concentration of people is ever self-sustaining. The Valley of the Nile, which has had perhaps 1000 people to the square mile for millenia, depends upon the vast headwater areas reaching south to Lake Victoria for its water and fertility. The same principle applies to the crowded downstream river margins of China and India.

The time must come when we shall have to deal openly, honestly, and realistically with the basic biological fact that numbers of organisms cannot multiply indefinitely within a finite area. And since our own species is under discussion, we must face the unparalleled conditions of increasing numbers and biological dominance combined with accelerating mobility, power, speed, and consumption on the part of the individual. Eventually we must come to grips with these fundamentals. Meanwhile we can, in my judgment, help matters greatly by admitting that conflicts of interest do exist, identifying them, and establishing some order of priority for conflicting claims.

I have no easy solutions to suggest. The first step in dealing with a scientific problem is to make it clear. This I have tried to do, aware of the fact that in our society solutions must be worked out by common consent—generally a painful process. There is a maxim among medical men that more mistakes come from not looking than from not knowing. So far as space is concerned, both looking and knowing are involved.

Training in Science

Much concern is now being expressed for better science training. Here at least we can make a sound, if modest, beginning. Training in the rudiments of science—asking, observing, and reasoning—should begin along with training in the mother tongue and be a part of the same process. College science, training as it does both scientist and citizen, should be taught in context with the rest of human knowledge and experience. It should certainly be a convincing and challenging aspect of education. How far it falls short of these ideals one can discover by asking those who have been exposed to it. Always excepting those who have an innate taste for science, the average college graduate, in my experience, does not retain enough for literate conversation upon the subject, let alone enough understanding to use it in civic affairs. Too often his mood is one of active distaste.

As a rule he has been required to take *a* course in *a* science weighted too often for the benefit of those who must go on in the particular field. How many times I have been told by colleagues: "We must teach it this way, or our students will not be ready for the next course." Such a philosophy misses the fact that by sacrificing insight to detail, fine intellects that might be potential candidates for further work may be lost.

Nor does the mischief stop there. No one science by itself can give that balanced view of the world of nature so essential to the citizen in our modern culture. A peep-show, no matter how good, is no substitute for a panorama. Until citizens, administrators, engineers, and businessmen become aware of the broad sweep of science, we may expect to see it applied, as it has been so largely, for immediate return rather than ultimate and lasting benefit.

Education and Self-Discipline

Let us, therefore, avoid the folly of thinking that science can be separated from the broader problem of education and self-discipline. The present hue and cry for more and better science education could easily lead us into the trap that caught the Germans in 1914. More and better science teaching we must have, not merely to produce needed scientists, but to create an atmosphere of scientific literacy among citizens at large. Only by general understanding and consent can truly creative science be sustained within our system of society and its results applied for the ultimate welfare of mankind.

Liberal education today should require not less than two years of college science, based on a skilfully planned and interwoven sequence dealing with time, space, motion, matter, and the earth and

its inhabitants. Nothing less than this is adequate for a proper appraisal of the natural world and our role as a part of it. This experience should be obtained at the hands of men who believe in it, who have status with their colleagues, and who are in intellectual communication with each other. There is no place for loose ends or superficial business in such an enterprise. Nor can it be carried on without the actual contact with phenomena in laboratory and field. Science that is merely verbalized is dead stuff.

But to this end it is equally essential that the educated individual must acquire such experience in the context of history, the arts, and an understanding of his own species. As a rough objective, I would propose turning out a product aware of what is going on around him in the world of nature and of man, able and willing to relate the present to the past and to the future in both thought and action.

To do this we must recognize with greater frankness than we have that there are vast differences among individuals. Let us learn to look upon these differences with respect, as a source of enrichment rather than discrimination, training each, honoring each, and expecting service from each according to his gifts. Let not the slow impede the fast, nor the fast bewilder and condemn the slow.

With a population set to double in less than half a century, with a national space which, though vast, is finite both in area and quality, with each individual making growing demands, moving faster and further by a factor of at least ten, we have on our hands a problem without precedent in geological history. But if we sense the problem and believe it worth solving, we can solve it.

Our future security may depend less upon priority in exploring outer space than upon our wisdom in managing the space in which we live.

Eskimo Longevity in Northern Alaska

Vilhjalmur Stefansson

Eskimo longevity in pre-white times is at best a matter of informed guessing, for "they took no care to reckon the years as they passed." But in northern Alaska their health, and other factors that bear on longevity, have been under study since 1852, and the records seem trustworthy. Beginning with the 1890's we have statistics resting on birth, baptism, and death certificates made by medical missionaries. Based on these formal documents is the conclusion that the longevity of northern Alaska Eskimos is greatly inferior to ours. By extrapolation, many have concluded that longevities were similarly inferior in the pre-white time. This extrapolation I now propose to scrutinize through the transition stage of Eskimo culture, from the first wintering of white men at Point Barrow in 1852 to the beginning of formal records, say around 1900.

A Recent Opinion

For this review, I take departure from one of the most recent of well-based longevity guesses, that of a doctor who was for 16 years in charge of the Presbyterian medical mission at Barrow, Alaska.

A preliminary year among the Eskimos was spent by Henry W. Greist and by his trained-nurse wife, Mollie Ward Greist, at Cape Prince of Wales on Bering Strait, during the season 1920–1921. In 1921 the Greists took charge of the Barrow mission and hospital, to remain till 1937. Greist died at his Indiana home in 1955, after finishing, but without publishing, a book, "Seventeen Years With the Eskimos." Mrs. Griest has lent me the manuscript and permits me to quote from its chapter XXIV:

"For untold centuries . . . the Eskimo of the far North had solely a carnivorous diet. . . . He was healthy . . . with rosy cheeks, with vigor and brawn. . . . He suffered from neither tuberculosis nor any venereal disease; and had rheumatism, if at all, to a limited degree. Barring accidents, starvation during lean years, or epidemics of unknown character, he lived to a very great age with his teeth intact, but worn to the gums since he used his teeth as a third hand. . . . When starches and sugars were introduced by the whalers and traders he at once began the development of carious teeth, something he never had had previously."

Earliest Observations

Having cited this recent opinion, I turn to the oldest one known to us: "Observations on the western Eskimos and the country they inhabit; from notes taken during two years at Point Barrow by Mr. John Simpson, surgeon R.N., Her Majesty's Discovery Ship *Plover*" (London, 1855).

During the second of his 1852–1854 winterings, Simpson counted 309 persons at the larger of the two villages and estimated the smaller at about three-fourths of this number; this made a total resident population, whom he saw continuously, of about 540. As transients, during the summer boating and winter sledging seasons, he must have seen an additional similar number. He reports, therefore, on about 1000 people for two years.

"These people are by no means the dwarfish race they were formerly supposed to be. . . . [They] are robust, muscular and active, inclining rather to spareness than corpulence. . . . In the young the complexion is comparatively fair, presenting a remarkably healthy appearance . . . before middle life, however, this, from exposure, gives place to a weather-beaten appearance, so that it is difficult to guess their ages. . . . The expression of the countenance is one of

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habitual good-humor. . . . While young, the women are generally well-formed and good-looking.

"The physical constitution of both sexes is strong. . . . Extreme longevity is probably not unknown among them; but as they take no heed to number the years as they pass, they can form no guess of their own ages. . . . Judging altogether from appearance, a man whom I saw in the neighbourhood of Kotzebue Sound could not be less than eighty years of age. He had long been confined to his bed, and appeared quite in his dotage. There was another at Point Barrow whose wrinkled face, silvery hair, toothless gums, and shrunk limbs indicated an age nothing short of seventy-five. This man died in the month of April, 1853. . . . There is another man still alive who is said to be a few years older. . . . In disposition they are good-humored and cheerful, seemingly burdened with no care.

"For tender solicitude with which their own infancy and childhood have been tended, in their treatment of their aged and infirm parents they make a return which redounds to their credit, for they not only give them food and clothing, sharing with them every comfort they possess, but on their longest and most fatiguing journeys make provision for their conveyance. In this way I witnessed among the people of fourteen summer tents and as many boats, one crippled old man, a blind and helpless old woman, two grown-up women with sprained ankles, and one other old invalid, besides children of various ages, carried by their respective families, who had done the same for the two first during many successive summers. . . . Orphaned children are provided for in the same way. . . . We have never heard of the sick and aged being left to perish.

"The age at which women are married is probably in general fifteen or sixteen. They do not commonly bear children before twenty; and there is usually an interval of four years or more between births. . . .

"[By the use of oil-burning stone lamps] not only a good light but a great deal of heat may be produced, so that the temperature of a [winter] hut is seldom below 70°F., and so great a care is taken to keep it trimmed, no offensive degree of smoke arises . . . there is near the middle of the roof a funnel in which a stiff hide is inserted to carry off the vitiated air from the inside of the hut. When the place is too crowded and the temperature too high [a further opening in the roof may be provided]."

Point Barrow Expedition

The *Plover* left its two-year anchorage in the summer of 1854. New England whalers began to pay visits to Barrow that year, no doubt bringing some contagious diseases; but except for these illnesses the people's way of life had not been as yet materially altered by the third decade after Simpson, when the United States Government established the International Polar Station, which was to become the nucleus of what is now Barrow village. The commander was Lieutenant Patrick Henry Ray; but, though his report is excellent, we use here the even more pertinent "Ethnological Results of the Point Barrow Expedition" by John Murdoch, as published in the *Ninth Annual Report of the Bureau of Ethnology* (Washington, D.C., 1892).

On physical characters Murdoch quotes Simpson a good deal, usually with approval. He agrees approximately regarding stature and concurs in the opinion that the Barrow Eskimos "incline rather to spareness than corpulence." He further agrees that "the general expression is good humored and attractive." He says "the males, even when very young, are remarkable for their graceful and dignified carriage. . . . In walking they move with long swinging elastic strides, the toes well turned out and the arms swinging. I can not agree with Dr. Simpson that the turning out of the toes gives 'a certain peculiarity to their gait difficult to describe.' I should say that they walk like well-built athletic white men.

"It was impossible to learn with certainty the age at which women first bear children, from the impossibility to learn the age of individuals in the absence of any fixed method of reckoning time. Dr. Simpson states they do not commonly bear children before the age of twenty, and we certainly saw no mothers who appeared to be younger than this. . . . It is exceedingly difficult, for the reason explained above, to form any estimate of the age to which these people live. . . . Men or women who appeared to be 60 or over were rare. Yuksinga, the so-called chief of Nuwuk [Point Barrow village] [who] was old enough to be a man of considerable influence at the time the *Plover* wintered at Point Barrow (1852–54) was in 1881 a feeble, bowed, tottering old man, very deaf and almost blind, but his mental faculties [were] apparently unimpaired."

Health and Food

Under "Pathology" Murdoch deals with so many things that to follow him all the way would lead us far afield. I quote mainly what might be supposed to have marked bearing on longevity.

"A few cases, one fatal, of hemorrhage of the lungs were observed, which were probably aggravated by the universal habit of inhaling tobacco smoke. [Elsewhere Murdoch explains that the Barrow Eskimos used to get tobacco from China, through Siberia, long before the arrival of the Russians in the 17th century.] Cutaneous diseases are rare. A severe ulcer on the leg, of long standing, was cured by our surgeon . . . and one man had lost the cartilage of his nose and was marked all over the body with hideous scars from what appeared to be scrofulous disease. A single case of tumor on the deltoid muscle was observed. . . ."

Under "Pathology" come, as a digression, remarks on how the Barrow people took care of the infirm. "Dr. Sutherland . . . expresses the opinion that 'an individual in such a state [totally blind] would be quite unfit for the life of toil and hardship to which the hardy Esquimaux are exposed. The neglect consequent on this helpless condition most probably cuts off its afflicted objects.' This seems quite reasonable on *a priori* grounds, but nevertheless the blind man at Cape Smythe had lived to middle age in very comfortable circumstances. . . .

"As a rule, they are quick witted and intelligent. . . . In disposition they are lighthearted and cheerful, not easily cast down by sorrow or misfortune. . . .

"The food of these people consists almost entirely of animal substances. . . . We saw and heard nothing . . . of eating the half-digested contents of the stomach of the reindeer. . . .

"As far as our observations go these people eat little, if any, more fat than civilized man; and, as a rule, not by itself. . . . It is usually supposed, and generally stated in the popular accounts of the Eskimos that it is a physical necessity for them to eat enormous quantities of blubber in order to obtain a sufficient amount of carbon to enable them to maintain their animal heat in the cold climate which they inhabit. A careful comparison, however, of the reports of

actual observers shows that an excessive eating of fat is not the rule. . . .

"We saw this people eat no vegetable substances, though they informed us that the buds of the willow were sometimes eaten [especially in time of famine].

"Of late years they have acquired a fondness for many kinds of civilized food, especially bread of any kind, flour, sugar, and molasses, and some of them are learning to like salt. . . .

"Food is generally cooked. . . . Meat of all kinds is generally boiled . . . and the broth thus made is drunk. . . . Fish are also boiled but are often eaten raw. . . . Meat is sometimes eaten raw frozen. . . . When . . . living in winter houses they . . . have no regular time for meals, but eat whenever [they are] hungry and have leisure. The women seem to keep a supply of cooked food on hand for anyone to eat. . . .

"When a family returns from the hunt . . . they usually keep open house for a day or two. The women of the household, with sometimes the help of a neighbor or two, keep the pot continually boiling, sending in [from the cookhouse] dishes of meat at intervals, while the house is full of guests who stay for a short time, eating, smoking, and chatting, and then retire to make room for others. Messes are sometimes sent out to invalids who cannot come to the feast. They are large eaters, some of them, especially the women, eating all the time when they have plenty; but we never saw them gorge themselves in the manner described by Dr. Kane . . . and other writers."

Murdoch says the Barrow Eskimos are heavy drinkers of cold water. "This great fondness for plenty of cold water has been often noticed among the Eskimos elsewhere. . . . The women tend the lamps with great care . . . the lamp burns with scarcely any smoke and a bright flame the size [length] of which is regulated by kindling more or less of the wick."

Dwellings

Murdoch does not say anything (that I have found) about how hot the interiors of the Barrow houses were in winter. But he gives the right impression by his illustration on page 74, which shows a man seated on what the Danes call a "brix"; he is stripped to a loin strip, which is correct. The children are naked. In the afternoon, the temperature would rise from the midday norm of around 70°F (which Simpson gives as the low temperature of the winter house) to 80° and 100° around dinnertime, then dropping to 70° for sleeping.

Contacts with Europeans

On previous contacts with Europeans, such as might be supposed to affect longevity, Murdoch says: "Until the visit of the *Blossom*'s barge in 1826 these people had never seen a white man. . . . [The barge party] landed only at Refuge Inlet, and had but little intercourse with the natives His visit seemed to have been forgotten by the time of the *Plover*'s stay at Point Barrow, though [Thomas] Simpson [who] found people there early in the morning of August 4 . . . stayed till 1 o'clock in the afternoon. On his return to Point Tangent some of the natives accompanied him . . . where he parted from them August 6, so his whole intercourse with them was confined to less than a week. [This was the Dease and Simpson expedition in 1837].

"The next white men who landed at Point Barrow were the party in the *Plover*'s boats . . . and the crew of Mr. Sheldon's yacht, the *Nancy Dawson,* the summer 1849 . . . the crews were ashore a couple of days and did a little trading. The exploring ships *Enterprise* and *Investigator* also had casual meetings [as they passed]. . . ."

After telling of Maguire and Simpson in the *Plover* (1852–1854), Murdoch says: "We found [in 1881] that the elder natives remember Maguire, whom they called 'Magwa,' very well. . . . It was difficult to see the *Plover's* visit had exerted any permanent influence on these people. In fact, Dr. Simpson's account of their habits and customs would serve very well for the present time. . . . Since 1854, when the first whalers came as far north as the Point, there has hardly been a season in which ships have not visited. . . . The chief change resulting from this intercourse with the whites has been the introduction of firearms. . . . They have however adopted very few civilized habits. They have contracted a taste for civilized food, especially hard bread and flour, but this they are unable to obtain for 10 months in the year and they are thus obliged to adhere to their former habits . . . they struck me as an essentially conservative people . . . the one unmitigated evil has been the introduction of spirits. . . .

"The habitual drink is water, which the people consume in great quantities . . . and like to have it very cold. . . . When tramping about in winter they eat large quantities of ice and snow. . . . This great fondness for plenty of cold water has been often noticed among the Eskimo elsewhere. . . ."

"The only narcotic in use among these people is tobacco . . . which has been in use among them from the earliest time. . . . Tobacco is used only for chewing and smoking [not as snuff]. . . . Men and women and even children, though the latter be but 2 or 3 years old and unweaned . . . keep a chew, often of enormous size, constantly in the mouth. . . . The juice is not spit out but swallowed, with the saliva, without producing any sign of nausea. . . . Tobacco is smoked in pipes of peculiar pattern [the so-called opium pipe]."

Home Life

Perhaps because it is ingrained in European thinking that "savages" dominate their women, there are many who claim that the Eskimo male does this. Therefore I quote Murdoch (page 413) on the subject, as it has some bearing on home life and therefore on longevity:

"The women appear to stand on a footing of perfect equality with the men, both in the family and the community. The wife is the constant and trusted companion of the man in everything except the hunt, and her opinion is sought in every bargain or other important undertaking." Here Murdoch has a footnote: "Compare Parry, 2nd voyage, pp. 526, 528. Nordenskiold, vol. I, page 449: The women are 'treated as the equal of the men, and the wife was always consulted by the husband when a more important bargain than usual was to be made.' This statement is applicable, word for word, to the women of Point Barrow.

"Children are nursed until they are 3 or 4 years old, according to what appears to be the universal habit among Eskimos. . . . The child is carried naked on its mother's back under her clothes and held up by the girdle. . . . When she wishes to nurse it she loosens her girdle and slips it around to the breast without bringing it out into the air. . . .

"We never heard of a single case of infanticide; and, indeed, children were so scarce and seemed so highly prized that we never even thought to enquire if infanticide was ever practiced . . . the affection of parents for their children is extreme, and the children seem to be thoroughly worthy of it. They show hardly a trace of fretfulness and petulance so common among civilized children, and though indulged to an extreme extent are remarkably obedient. Cor-

poreal punishment appears to be absolutely unknown, and children are rarely chided or punished in any way. Indeed they seldom deserve it; for, in spite of the freedom which they are allowed, they do not often get into any mischief. . . . The older children take very good care of the smaller ones. . . ." Murdoch here gives many quotations to indicate that his description of the Eskimo way of life in regard to children applies to the whole Eskimo [and Chakchee] world.

I cease quoting Murdoch of 1881–1883, as I did Simpson of 1852–1854, with no precise dating of even one instance of great longevity but with the two students agreeing that some persons looked as if they might be past 60, a very few as if past 70, and one or two as if past 80. This was the nearest to exactness that either thought possible, in view of no one's having counted years, in accordance with native custom.

"Lady McGuire"

But a traveler of three decades later was able to get one approximate dating. Diamond Jenness, eventually anthropologist of the National Museum of Canada but at the time anthropologist of the Canadian Arctic Expedition of 1913–1918, met, on the coast east of Point Barrow, a woman whom he called "Lady McGuire" because, as a young lady, she had been aboard the *Blossom,* in 1852. The charming *Dawn in Alaska* [University of Minnesota Press, 1957] has in its pages several memorable characters, whom Jenness came to know as he sledged back and forth along the coast between Point Barrow and the Canadian boundary during the season 1913–1914; of these, none is more endearing than this octogenarian. Under the title "Lady McGuire," she appears several times, the last time on page 129:

"The old lady was extra gay that evening, and with good reason; for shortly after we arrived one of her granddaughters, whom she had not seen for six months, entered the house unheralded, accompanied by her ten-year-old son. Eskimos seldom display their affection outwardly, although they are as devoted to their family as we are; but . . . not one of them would have criticized this octogenarian grandmother [for her boisterous affection]."

In reply to my letter on his over-80 estimate, Jenness said that Lady McGuire might not have been more than 75 in 1914 but that, to him, she was in the octogenarian category, implying that she might have been past 80. When he and I last saw her, in both instances early in 1914, Lady McGuire seemed, at least to me, as if she might have had many years ahead of her.

Informed Guesses

So, in effect, we have all the informed guessers agreeing with the first of them, Simpson, that in the Barrow region of northern Alaska, extreme longevity was not unknown in pre-white times or in the transition stage of Europeanization that precedes our regular statistics. There is agreement, too, though we do not go into it here, that many of those who have died young since birth certificates became available have been victims of European-introduced diseases, among them measles, venereal afflictions, and tuberculosis.

Reginald A. Daly, Geologist

The philosophy that guided the scientific thinking of the late Reginald A. Daly was based on two cardinal principles: imaginative thinking and the necessity of synthesis. This philosophy is well expressed in the introduction to his first book, *Igneous Rocks and Their Origin,* published in 1914.

He points out that a fertile imagination, coupled with a training in physical principles, is vital to science. Geology, because it involves thinking about the invisible parts of the earth and epochs long since passed, is peculiarly suited to stimulate the regulated imagination. When, 30 years ago, Daly was teaching the elementary course in physical geology at Harvard, he emphasized that geology should develop the student's "imaginative muscle."

Daly did not hesitate to speculate even when sufficient data were not available. When lecturing or writing on his theory that submarine canyons were cut by mud-laden currents at the bottom of the sea, he always disarmed his potential critics in advance by admitting the theory's highly speculative character and by expressing hope that those carrying on the field investigations would examine critically his theory and those of others.

Daly was a strong advocate of synthesis. In his book of 1914 he said that science was "drowning in facts." He expressed the hope that geology might find its superman, who would show us the building behind the scaffolding of myriad isolated facts. Daly himself came as near as anyone to being that superman. His six books testify to his ability to correlate countless observations into coherent genetic syntheses.

Daly's accomplishments in field geology were great. His early work, in the late 1890's and early 1900's, was done chiefly in New England, although he made one trip to Labrador. His most colossal task, which occupied six field seasons, from 1901 to 1907, was an investigation of the geology along the American-Canadian boundary between the Rocky Mountain front in Alberta and the Pacific Ocean—a rugged, inaccessible region. In the three-volume memoir of the Geological Survey of Canada that resulted from this study, he said: "No geologically-trained assistant was employed in any part of the field. The work was, therefore, slow. Each traverse meant a more or less taxing mountain climb through brush or brulé." After additional field seasons in Canada, his work took him to Hawaii, Samoa, Saint Helena, Ascension Island, and South Africa. His last field work was done in the early 1920's, when he was slightly more than 50 years old. Thereafter he was able to devote much of his time to the writing of books and papers, in which he synthesized the data gathered by others.

Daly was a superb lecturer. He had the ability to present his ideas to an audience in a clear and concise manner. At the end of a lecture in elementary geology his students would often applaud vigorously. His books are similarly clearly written, and he was a master at preparing line drawings.

Daly's fertile imagination led him into many aspects of geology and geophysics. He not only contributed many new ideas but, above all, in focusing attention on countless problems, he stimulated many others to gather data that were essential to the solution of these problems. For the first 25 years of his scientific career he was primarily concerned with igneous rocks. His early field work at Mount Ascutney, Vermont, led him to the problem of the emplacement of igneous rocks and the development of the hypothesis of magmatic stoping. Corollary subjects were the classification and formation of igneous bodies, intrusive and extrusive, as well as the average chemical composition of the various kinds of igneous rocks and their proportions in the crust of the earth. This in turn led him to examine in detail the theory of magmatic differentiation to explain the large variety in igneous rocks. He concluded that beneath the crust there must be a world-encircling liquid basaltic substratum which, when injected into the crust, initiated a whole series of events that produced numerous rock types.

But during this same period he was thinking about several other apparently unrelated problems. Puzzled by the extreme rarity of fossils in Precambian rocks, as many others have been, he suggested that the seas of that time were "limeless." Intrigued by the problem of coral reefs, he developed his glacial control theory, which in recent years has been invoked to explain many other geological phenomena. Very early in his career he worked on such diverse subjects as the physiography of Acadia, the optical properties of amphiboles and pyroxenes, and the postglacial uplift of the coast of Labrador.

Although he had long realized that the cause of deformation of the crust of the earth must be sought in the underlying invisible mantle, his interest in the physical properties of rocks and in geophysics did not begin until the mid-1920's. Convinced that a new approach to the investigation of the interior of the earth was essential, Daly and his colleagues in geology and related sciences, through the munificence of an anonymous donor, succeeded in establishing at Harvard the Committee on Geophysics and Experimental Geology. In the last decades of his life Daly was an enthusiastic leader in planning the program of this committee, constantly suggesting problems that needed solutions, as well as answers to other problems.

Although he occasionally returned to problems connected with igneous rocks, his later papers were more concerned with the earth as a whole, especially its interior. When his *Igneous Rocks and Their Origin* was revised in 1933, the title was changed to *Igneous Rocks and the Depths of the Earth*. Some of his papers dealt with the strength and moduli of elasticity of the earth's outer shells, isostasy, the figure of the earth, and the nature of the interior of the earth. He spoke of the waxing and waning of the Pleistocene ice caps as nature's experiment to help us determine the strength of the earth. But during this period he did not neglect other problems. Twenty years ago he realized that his glacial-control theory, first devised to explain coral reefs, might also have a bearing on the problem of submarine canyons. With the lowering of sea level, muds on the continental shelf would be incorporated in currents flowing down the continental slope; these turbidity currents cut the canyons. In his last paper he returned to the igneous rocks, to combat the heretical idea that most granites are the result of metasomatic replacement rather than products of a crystallizing melt.

His influence extended far beyond the limits of North America. A. L. Hall, in his classic memoir on the "Bushveld Igneous Complex of the Central Transvaal," begins his introduction as follows: "In the history of geological research in South Africa the year 1922 is a landmark, for it saw the visit of the Shaler Memorial Expedition, whose members were Professor R. A. Daly and Professor C. Palache, both from Harvard University. . . ."

Born in Napanee, Ontario, 19 May 1871, Daly received his A.B. degree from the University of Toronto in 1891 and his M.A. and Ph.D. degrees from Harvard in 1893 and 1896, respectively. He spent the two following years studying at Heidelberg and Paris. He taught at Harvard from 1895 to 1896 and from 1898 to 1901. From 1901 to 1907 he was geologist for the Canadian International Boundary Survey. From 1907 to 1912 he was professor of physical geology at Massachusetts Institute of Technology, and from 1912 to 1942, Sturgis Hooper professor of geology at Harvard. Professor Daly died at his home in Cambridge, Massachusetts, on 19 September, after a long illness.

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News of Science

Hard Look at Missile Programs

The current inquiry of the Senate Preparedness Investigating Subcommittee is showing how difficulties arise in our missile programs because the new developments in science and weaponry do not fit readily into the present land-sea-air division of the armed services. The difficulties that are resulting from a separate Army, Navy, and Air Force include interservice rivalry, overlapping programs, and an involved superstructure of command. The subcommittee recessed on 17 December 1957, but on 6 January 1958 it will continue its efforts to find out what is wrong in the Department of Defense and what can be done about it.

So far testimony before the subcommittee, as well as the suggestions received from approximately 100 experts interviewed by the subcommittee's staff, shows that money alone is not the answer to the Soviet challenge. Something in the way of a new organizational set-up is also needed. Under the present system, the missile programs are spread among the three military services, with loose supervision by the Department of Defense. Although the power of William H. Holaday, director of guided missiles, was recently increased, it appears from the testimony that he does not exert fundamental control over the programs in the individual services.

Sentiment in favor of installing a missile chief who in fact does have full control seems to be growing in Congress. Senator Lyndon Johnson, Democrat of Texas and chairman of the subcommittee, said that the chief fault in the missile programs was the failure in the Pentagon to make "hard, firm decisions at high levels." He added that Neil H. McElroy, Secretary of Defense, should find an authoritative man for the job.

Testimony before the subcommittee also touched on the problems of outer space. Werner von Braun, civilian chief of the Army's ballistic missile program, urged the creation of a national space agency with an annual budget of about $1.5 billion. The new agency, Von Braun said, could undertake a 5-year program "to have a man orbiting the earth on a returnable basis" and a 10-year program for a manned space station. Both Von Braun and his military commander, Major General John S. Medaris, testified that their work on the 200-mile Redstone missile and the 1500-mile Jupiter was hampered by insufficient funds and by lack of a central missile authority.

AAAS-Anne Frankel Rosenthal Award

Roy Hertz, chief of the endocrinology branch, National Cancer Institute, has received the 1957 AAAS-Anne Frankel Rosenthal Memorial Award for Cancer Research, which consists of $1000 that is provided by the Richard and Hinda Rosenthal Foundation. The award was presented during the recent meeting of the AAAS in Indianapolis, Ind.

For the past decade Hertz and his colleagues have been concerned with the endocrine factors involved in normal and cancerous growth. Their studies have been directed at both a basic and applied clinical level. In 1947 Hertz showed that hormone-dependent organs such as the breast and uterus require for their growth specific dietary factors such as folic acid. He further demonstrated the complete inhibition of such hormone-induced growth by administering folic acid or purine antagonists. These antagonists are so similar in chemical composition to corresponding dietary or metabolic factors that they prevent the normal growth function of these essential substances.

More recently, in collaboration with M. C. Li and D. M. Bergenstal, this knowledge of interference with abnormal tissue growth has been effectively applied in the treatment of a rare but highly malignant tumor of the uterus, namely choriocarcinoma. This tumor arises during or after pregnancy from the organ which would normally develop into the placenta. In women with choriocarcinoma this organ has turned into a malignant tumor which grows rapidly through the uterus and then spreads to the lungs and brain. It usually kills the patient in less than a year.

In 15 women afflicted with this rare condition, the application of an especially devised intensive regimen of treatment with a folic acid antagonist, methotrexate, has led to apparently complete suppression of the disease in five patients and almost complete suppression in five others. These ten women are now restored to normal living and have been entirely free of symptoms for periods ranging from 3 months to 2 years. Three of the group of 15 are still under treatment and two died during early phases of attempted treatment of their far-advanced disease. The full value of this treatment remains to be determined, but it is already entirely clear that patients with this type of malignancy can be markedly improved with the folic antagonists.

Hertz, in collaboration with William W. Tullner, has also developed the first nonhormonal drug capable of suppressing the output of cortisone and related hormones by the adrenal gland and by tumors arising in this vital organ. This inhibitory substance is called Amphenone. Amphenone is now used in patients suffering either from adrenal enlargement or from adrenal cancer in order to suppress the disorders produced by excessive adrenal hormones. These disorders, which are similar to those resulting from excessive cortisone administration, include diabetes, high blood pressure, acne, and mental abnormalities. However, this hormonal suppression is not accompanied by any restraining effect on the adrenal cancer. Moreover, the toxic side effects of Amphenone are such as to limit its practical usefulness to highly selected cases.

Pay Up for Some Government Scientists

On 10 December the U.S. Government's Civil Service Commission announced pay increases for some 48,000 Government physical scientists and engineers. The increases, which will be made before the end of December, were necessitated, according to the commission, because "of evidence that the Government is unable to obtain critically needed scientists and engineers in sufficient supply at present rates."

The increases will not be across the board, but will be achieved by bringing all scientists in each grade to the top salary for that grade; those already receiving the top salary will get no increase. For those whose pay will rise, the increase will range from $135 to $1080 a year. Employees in grades from GS 9 to 17 will be paid the maximum salaries for their grades, as follows: 9, $6250; 10, $6725; 11, $7465; 12, $8645; 13, $10,065; 14, $11,395; 15, $12,690; 16, $13,760; 17, $14,835. The highest grade, GS 18, remains at $16,000, the top salary for a classified employee.

The raises apply to physical scientists —physicists, chemists, geophysicists, and so on—and to biochemists, but not to

bacteriologists and biologists. The raises were immediately criticized on several grounds: by the bacteriologists and biologists who thought that they had been unfairly left out and by those who had already reached the top salaries for their grades. The latter group objected to the elimination of pay differentials within their grades and to the provision that new employees would enter any particular level at the top salary for that level, a practice that would negate pay differentials on the basis of merit within a particular category.

In general, Government scientists, who thought the increases inadequate and belated, doubted that the changes would be effective in stemming the loss of scientists to industry, since top pay in each category was not changed. Some also doubted the realism of the Civil Service Commission's expectation that the increases would enable the Government to obtain 4000 additional scientists and engineers within the next year.

Other critics pointed out that the increases pose problems for the future: within a year or so some means will have to be found to provide for progressive increments in salary and for merit increases if the Government is to compete effectively for scientists and engineers.

Evolutionary Terminology

Julian Huxley [*Nature* **180**, 454 (7 Sept. 1957)] believes that the time has now come when there is need to define the major types of evolutionary process more strictly. He recognizes three such processes, leading, respectively, to divergence and variety ("cladogenesis"), to adaptedness and biological improvement ("anagenesis"), and to stabilization and persistence of type ("stasigenesis"). *Cladogenesis* and *anagenesis* have been taken over (the latter with some extension of meaning) from Rensch [*Neuere Probleme der Abstammungslehre* (Stuttgart, Germany, ed. 2, 1954)], whereas *stasigenesis* is a new term. "Clades" are delimitable monophyletic units resulting from "cladogenesis." "Grades" are delimitable and persistent "anagenetic" units produced by "stasigenesis." Most delimitable taxa therefore will at once be both clades and grades, yet others are grades which may or may not also be single clades. "Evolutionary areas" will appear when "anagenetic" improvement is plotted against "cladogenetic" divergence on a two-way graph with time eliminated.

Huxley believes that the implications of these three cooperating evolutionary processes have not been made explicit and that taxonomy will have to contemplate a two-way system of classification which gives due consideration to the facts of biological improvement and persistence of type as well as to the facts of phylogenetic divergence. This will, he thinks, presumably involve some new terminology.

No one interested in and believing in evolution will attempt to deny the existence of the general evolutionary processes which Huxley discusses, despite his dubious recognition of stasigenesis as something fundamentally apart from anagenesis and his use of the essentially anthropocentric term *biological improvement*. Yet it seems doubtful whether all of his proposed terms will really be of any great help in understanding the phenomena of evolution. The only justification of any new term is its demonstrable need. One major source of new terms stems from a real need for ease of communication, from a need for the ability to describe things, or phenomena, or even concepts tersely, with great conservation of words. On the other hand, far too many technical terms represent nothing other than pretentious coinage—to wit, the subconscious human need to cover our ignorance of a phenomenon by assigning to it a high-sounding technical exoticism. I do not wish to do Huxley an injustice, but I cannot help but wonder whether some of his proposed evolutionary terminology does not properly fall into this category. His proposal of *cron* (to denote 1 million years as "the basic unit of evolutionary time"), *kilocron* (for 10^9 years), and *millicron* (for 1000 years) as the basis of "a suitable chronological terminology" does nothing to remove this suspicion. Current estimates of geological time are at best mere approximations and, as such, are constantly subject to revision. The use of fancy terms for such approximations can only serve to clothe them with a spurious reality.

Similarly, one reads with misgivings the proposal of the "gradal" term, *Psychozoa,* for man. In justification, Huxley states that "cladogenetically man constitutes only the single family Hominidae; but anagenetically he constitutes a grade equivalent in evolutionary importance to all other organisms taken together." When viewed historically, Linnaeus' optimistic designation of man as *Homo sapiens* may well be forgiven. It may be that I am unduly pessimistic; yet it seems a bit presumptuous for man to confer upon himself the designation "Psychozoa" in these days of increasing disintegration of human interpersonal and intersocial relations—disintegration that is occurring despite (and, paradoxically, as a result of) his tremendous material and technological achievements. This is scarcely a "biological improvement." It must be admitted, however, that man may yet justify the statement that "he constitutes a grade equivalent in evolutionary importance to all other organisms taken together"—either by eventual mastery of himself as well as of his environment or, ironically, by virtual annihilation of himself and the rest of the living world through the material accomplishments of his unparalleled and perhaps overspecialized brain.

The introduction of new scientific terms is inevitable and often highly desirable. It is a bit disturbing, however, to find one of the leading living students of organic evolution advocating a wholesale introduction of new, unnecessary terms that can only serve to burden this area of biology with a jargon—a jargon that is not needed by the specialist and which will only tend to confound and mislead the nonspecialist.

WILLIAM L. STRAUS, JR.
Johns Hopkins University

German Scientific Council

Federal Chancellor Adenauer and the Minister-Presidents of the States of West Germany signed in Bonn on 5 September an agreement to establish a German Scientific Council and an agreement on a federal subsidy to the states of 22 million marks in the current fiscal year for expanding engineering school facilities. Adenauer stated of the Scientific Council that West Germany will now have an organization that can provide an over-all survey of scientific work.

The task of the council will be fourfold: (i) to work out a plan for promoting science in the Federal Republic; (ii) to coordinate the plans of the federal and the state governments, and indicate priorities in research; (iii) to formulate an annual "first priority" program; and (iv) to recommend the use of funds provided for the advancement of science in the budgets of the federal and the state governments.

Formal constitution of the Scientific Council and appointment of members will probably require several months. The council will consist of 39 members who are either scientists or closely associated with science, or persons recognized in public life. The federal president will appoint 22 members, 16 of these through joint recommendation of the German Research Society, the Max Planck Society, and the West German Rectors' Conference, and six on the joint recommendation of the federal and state governments. These members will serve a 3-year term and may be reappointed. Seventeen members will be appointed by the federal and state governments, six of these by the federal government and one by each state government including the Saarland and Berlin.

The agreement on federal financial aid for engineering schools is intended

to relieve a temporary emergency situation. On the basis of the earlier Koenigstein Agreement, the states are already jointly supporting a number of research institutes, particularly those of the Max Planck Society. Under the new agreement, the federal government will assume 50 percent of the expenditures required to maintain these institutes in the fiscal year 1957. The states, in turn, must use the resulting 22 million mark fund for constructing new classrooms and laboratories and for equipping these facilities.

Chest X-ray Surveys

The great decrease in the number of tuberculosis cases and the recognition that even in low doses x-rays may be hazardous have led the U.S. Public Health Service to recommend that future mass x-ray surveys for tuberculosis be confined to those groups of the population in which the risk of infection is high. Among these are people admitted to hospitals, patients and employees of mental hospitals, inmates of penal institutions, inhabitants of slum areas, migrant laborers, and alcoholics. In groups in which the incidence of tuberculosis is low, the service recommends the use of the tuberculin skin test as a first step, to be followed by x-ray diagnosis only when the test is positive.

The Public Health Service also recommends frequent inspection of all x-ray equipment in order to protect people from unnecessary radiation:

"For many years it has been known that there is a risk of excessive radiation exposure involved in the use of x-ray machines. Current findings in this field that emphasize the significance of relatively low level radiation exposure, now serve to focus attention on the need to maintain and operate x-ray equipment in such a way as to eliminate all unnecessary radiation." The American Trudeau Society, a constituent association of the National Tuberculosis Association, has made essentially similar recommendations.

Surface Measurement of Gravity in Ocean Areas

The first successful surface measurements of gravity in the open sea were made on 22 November by J. Lamar Worzel, professor of geology at Columbia University's Lamont Geological Observatory. The measurements were made as part of a program to chart gravity variation throughout the world during the International Geophysical Year. Worzel used a new sea gravimeter developed by Anton Graf of Munich, Germany, to make the unprecedented surface measurements. The instrument was mounted on a gyro-stabilized platform installed aboard the *U.S.S. Compass Island*. Previously, gravity values for ocean areas had to be measured in submarines submerged to quiet depths.

Surface gravity measurements from the *Compass Island* were taken in 9 hours, as compared with 2 days for the earlier submarine measurements. The data were reduced in just a half-day, as compared with 2 weeks needed to adjust and compute the data from submarine measurements.

Although 80 percent of the earth's surface is covered by water, to date there have been only 4000 measurements of gravity at sea made throughout the world. Roughly half of these have been made by the Lamont Geological Observatory in the past 10 years.

Gravity measurements are used to determine the shape of the earth, the true direction of the earth's center, and the density of the material of the topmost layers. With gravity and seismic measurements together, the thickness of the earth's crust can also be calculated.

Gravity determination of the true vertical and the shape of the earth are important geodetic tools. Once sufficient values of gravity are taken over a wide enough area of the oceans, maps and charts will be greatly improved.

Contract for Observatory

The recently organized Association of Universities for Research in Astronomy, Inc., signed a contract on 13 December 1957 with the National Science Foundation to build and operate an optical astronomy observatory for basic research. Alan T. Waterman, director of the foundation, pointed out that the contract was in keeping with the foundation's established policy to support those basic research facilities for which private capital could not be expected. A sum of $3.1 million for the construction of an optical observatory was included in the foundation's appropriation for fiscal 1958.

The Association of Universities for Research in Astronomy, Inc., consists of seven universities, all with large observatories and all with strong programs of research and graduate instruction in astronomy. The universities are California, Chicago, Harvard, Indiana, Michigan, Ohio State, and Wisconsin. Other universities may be added as the project develops. The chief officers of the association are: president, R. R. McMath, who is director of the McMath-Hulbert Observatory, Michigan; vice president, F. K. Edmondson, who is chairman of the Department of Astronomy, Indiana; and secretary, J. M. Miller, who is assistant vice president of business affairs, California. The main office of the association is in Phoenix, Arizona.

Choice of a site for the astronomical observatory has been narrowed to three locations: Kitt Peak (6875 feet), 40 miles southwest of Tucson, Arizona; the Hualapai Mountains (7350 feet), 13 miles south of Kingman, Arizona; and Mormon Mountain (8440 feet), 35 miles south of Flagstaff, Arizona. A final decision about the site is expected in the middle of 1958. Initial plans for the instruments call for an 80-inch and a 36-inch telescope.

News Briefs

A newly formed subsidiary of Beckman Instruments, Inc., will occupy a new plant under construction in Glenrothes, Scotland. The new facility will engage in the manufacture of precision potentiometers for electronic instruments and systems.

* * *

The Board of Managers of Haverford College, a Quaker institution, announced recently that the college would not sponsor any applications for research grants from the Department of Defense.

* * *

The number of mental patients in the United States is decreasing for the second straight year, it has been announced by F. Barry Ryan, Jr., president of the National Association for Mental Health. There was an estimated decrease of 5000 patients between June 1956 and June 1957, and in 1956 there was a total decrease of more than 7000 patients.

* * *

The U.S. Department of Agriculture has begun a cooperative federal-state-local program for eradication of the imported fire ant. Eradication and control measures have begun in Louisiana and Georgia; they will be extended to other states.

* * *

Formation of Vitro International, with headquarters in Switzerland, was announced recently by J. Carlton Ward, Jr., president of Vitro Corporation of America, New York. The new division will represent all Vitro operations overseas.

* * *

A certificate of award and a silver cup have been presented to Argonne National Laboratory for a motion picture about its experimental boiling-water reactor. The award was won by the Argonne film at the Fourth International Electronic and Nuclear Energy Exhibition and Conference, held in Rome, Italy. Presentation was made at the U.S. Atomic Energy Commission's headquarters in Washington, D.C.

Scientists in the News

The *AIBS Bulletin* has requested that *Science* correct an erroneous report of the death of CARL F. SCHMIDT, of the department of pharmacology at the University of Pennsylvania, which was published in the *Bulletin's* November (1957) issue. The incorrect statement appeared in an editorial footnote to W. O. Fenn's article on "Scientific Manpower in Russia." Confusion of names caused the error: Karl P. Schmidt of the Chicago Natural History Museum died 24 Sept.

WILLARD F. LIBBY, commissioner of the U.S. Atomic Energy Commission, has won the 1958 Willard Gibbs Medal of the American Chemical Society's Chicago Section. He is being honored for his development of the "atomic time clock" method for dating geological age and for his discovery that tritium, a radioactive form of hydrogen, can be used to trace meteorological and geophysical processes.

GERALD M. RASSWEILER has succeeded EDWARD J. MARTIN as head of the General Motors Research Staff's physics and instrumentation department. Rassweiler, who joined General Motors in 1928 as research physicist, has specialized in x-ray spectroscopy, electron microscopy, ultrasonics, and electronics in their applications to problems of industrial research, development, and production. Martin, the first physicist to be employed by General Motors, is retiring after 33 years of service.

CHARLES E. RAVEN, personal chaplain to Queen Elizabeth of England and recent vice-chancellor of Cambridge University, has accepted an appointment as the University of Cincinnati College of Medicine's first visiting professor in the philosophy of science. The new post is supported by a grant from the John and Mary R. Markle Foundation. Raven, who will arrive in March, is a botanist who is interested in relations between science and religion.

JOHN T. BONNER, associate professor of biology at Princeton University, has been named advisory editor in biology for the publishing firm of Dodd, Mead & Company, Inc.

CHARLES B. METZ, professor in the Oceanographic Institute of Florida State University, has been named associate director, effective with the spring semester.

DANIEL BLAIN has announced his resignation as medical director of the American Psychiatric Association, effective 1 September 1958. He has been medical director since 1948.

Recent recipients of honorary degrees include the following:

JAMES H. DOOLITTLE, pioneer in aeronautics and vice president of the Shell Oil Company, from the University of Michigan.

CLIFFORD C. FURNAS, aeronautical engineer and chancellor of the University of Buffalo, from the University of Michigan.

WALTER D. LAMBERT, former chief of the gravity and astronomy section, U.S. Coast and Geodetic Survey, from Ohio State University.

DAEL L. WOLFLE, executive officer of the AAAS, from Ohio State University.

JAMES C. ZEDER, automotive engineer and vice president of the Chrysler Corporation, from the University of Michigan.

NELSON K. ORDWAY has been appointed professor of pediatrics at the Yale University School of Medicine, effective 1 January 1958. In recent years, Ordway's special interest has been congenital heart disease and electrolyte problems.

RICHARD S. ADAMS, assistant professor of dairy science at Pennsylvania State University, has been appointed cattle and sheep research specialist at the General Mills Larro Research Farm, Indianola, Iowa.

CRAWFORD H. GREENEWALT, president of the E. I. du Pont de Nemours & Company, received the 1957 William Procter Prize for Scientific Achievement of the Scientific Research Society of America during the recent AAAS Meeting in Indianapolis, Ind.

W. R. G. BAKER, a vice president of the General Electric Company, has retired to accept appointment by Syracuse University as vice president for research. He will also become president of the Syracuse University Research Corporation. In March, Baker is to receive the Founders' Award of the Institute of Radio Engineers as an outstanding administrative leader in electronics.

JOHN K. HODNETTE of Pittsburgh, Pa., vice president and general manager and a member of the board of directors, Westinghouse Electric Corporation, will receive the 1957 Edison Medal of the American Institute of Electrical Engineers. He is being honored "for his significant contributions to the electrical industry through creative design and development of transformer apparatus which marked new advances in protection, performance, and service. . . ." The medal will be presented at the opening general session of the AIEE's winter general meeting, which will be held at the Hotel Statler, New York, 3–7 Feb. 1958.

Recent Deaths

ROBERT BREWER, Philadelphia, Pa., 80; consulting engineer and pioneer in the field of aircraft and automotive design; 6 December.

GUY G. CAMPBELL, Chicago, 67; specialist in tropical medicine and former physician to Emperor Haile Selassie of Ethiopia; 2 December.

DEAN A. COLLINS, Princeton, N.J., 53; research professor of pharmacology at Temple University School of Medicine; 3 December.

LLOYD EMMONS, East Lansing, Mich., 72; dean emeritus of Michigan State University's School of Science and Arts and assistant director of the Michigan State Museum; 8 December.

CLAUD FULLER, Chattanooga, Tenn., 80; engineer, author, inventor, and specialist on firearms; 6 December.

BASIL M. GOLDSMITH, Rutherford, N.J., 49; material-control manager of the industrial tube division of the Allen B. Du Mont Laboratories; 6 December.

EDMUND HANCOCK, Stuart, Florida, 70; retired Bell Telephone Laboratories engineer; 3 December.

SIGFRED M. HAUGE, Lafayette, Ind.; 62; associate professor of biochemistry at Purdue University; 26 November.

JOSEPH E. MOORE, Baltimore, Md., 65; professor of medicine at Johns Hopkins Medical School, editor of the *Journal of Chronic Diseases,* and author of the authoritative work *The Modern Treatment of Syphilis* and of 180 books and papers; 6 December.

LOUIS H. POWELL, St. Paul, Minn.; director of the Science Museum, St. Paul, since 1931; 8 November.

GEORGE K. PRATT, Westport, Conn.; 66; psychiatrist on the neuropsychiatric staff of Bridgeport Hospital; author of a number of books on mental health; former member of the faculty of the New School for Social Research, the Brooklyn Institute of Arts and Sciences, and the Yale University School of Medicine; 11 December.

FLETCHER REYNOLDS, Cleveland, Ohio; 55; director of the Cleveland Zoo, past president of the American Association of Zoological Parks and Aquariums; 13 December.

ABBY H. TURNER, South Hadley, Mass., 82; professor emeritus of physiology at Mount Holyoke College; influential teacher and founder of its department of physiology; investigator of colloid osmotic pressure, circulatory reactions to gravity, and physiological status of young women; 26 November.

Reports

Tetraethyl Pyrophosphate and Acetylcholine in Periplaneta americana

The known effect of organophosphate insecticides is to inhibit cholinesterase (*1*) and to increase the acetylcholine content of the nervous tissue of insects (*2*). As yet no evidence has been obtained for other factors related to the increase of acetylcholine, although treatment of roaches with physostigmine points to a correlation between nervous activity and acetylcholine (*3*). Accordingly, male roaches of *Periplaneta americana* L. were treated topically with a lethal dose (5 μg per roach) of tetraethyl pyrophosphate, and the acetylcholine content of thoracic cords was determined on the rectus abdominis muscle of the frog. The methods of dissection and extraction of acetylcholine from roach cords have been described (*4, 5*); they avoided *in vitro* syntheses of acetylcholine. Correction for sensitizing agents was made (*6*), and values for acetylcholine refer to acetylcholine chloride. Electrophysiological observations were also carried out on the gross nerve activity of the ventral cord. The acetylcholine content of thoracic cords between 1 and 48 hours is shown in Fig. 1. The level of acetylcholine in normal roach cords was 79 ± 6 μg/g (*5*).

It may readily be seen that two distinct peaks of acetylcholine were found for the 48-hour period. The first, occurring at ½ hour, was coincident with a period of intense nervous activity. The second peak, strikingly greater than the initial one, was found at 24 hours. At this time the ventral cord was electrically dead. Furthermore, from 24 hours onward the roaches showed definite signs of necrosis, as shown by a darkening and discoloration of thoracic tissues, and at 48 hours, when the acetylcholine content had fallen to zero, it was almost impossible to remove the nerve cords. It is concluded that the rise of acetylcholine in roach thoracic ganglia is related initially to hyperactivity and later on to an effect on nervous tissue distinct from hyperactivity. In insects of small size for which only a single peak is obtained, it is possible that the two characteristics are inseparable.

Studies of the mode of action of tetraethyl pyrophosphate have produced evidence that the blood of treated roaches contained acetylcholine as determined by rectus abdominis muscle of frog, *Venus* heart assay, alkaline hydrolysis, and hydrolysis by cholinesterase. Normal blood contained no acetylcholine, and blood extracts for assay were prepared similar to that for nerve tissue to avoid sensitizing agents. The amount was higher at 2 hours than at 8 hours after treatment. The blood results suggest a possible release by the central nervous system, for at 2 hours the level of acetylcholine in the thoracic cord had decreased (Fig. 1). However, the amount in the blood was not sufficient to warrant such an assumption, and, should acetylcholine be released into the blood by the central nervous system, the strikingly higher amount found in the thoracic cord at 24 hours cannot be in a freely diffusible form.

In contrast, the blood of DDT-treated roaches contained no acetylcholine, nor was there an abnormal amount of acetylcholine in thoracic ganglia at prostration. Blood from roaches treated with either tetraethyl pyrophosphate or DDT induced nerve volleys in the isolated nervous system of the roach. Since this result was not due to acetylcholine, there is, perhaps, a common factor in the blood of roaches poisoned by DDT and by tetraethyl pyrophosphate. As shown in the blood physiology, there is a specific difference in the mode of action of the two insecticides.

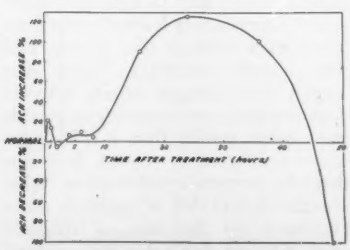

Fig. 1. Total acetylcholine content of thoracic nerve cord of roaches treated topically with 5 μg of tetraethyl pyrophosphate per roach.

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10 October 1957

Differential Effects of Reserpine on Conditioned Responses in Cats

In order to study the differential effects of drug administration on a number of conditioned responses in the same animal, eight cats were trained in three tasks: (i) to traverse an elevated runway for visible food; (ii) to discriminate between a circle and a square for food in a Yerkes box; and (iii) to avoid shock in a hurdle box within 5 seconds of presentation of either an auditory (1200 cy/sec tone) or a visual (darkened compartment) stimulus. All cats were trained to 100 percent accuracy in avoidance and to 95 percent accuracy on three successive days in pattern discrimination. A cannula was then implanted into one lateral ventricle of the brain to permit central injection of solutions without anesthesia or other disturbance of the animal.

By use of the behavioral indices, the effects of central and peripheral injections of various substances were compared, and the interactions of these substances were studied. Materials studied included reserpine, serotonin, iproniazid, sodium pentobarbital, epinephrine, norepinephrine, acetylcholine, adrenocorticotrophic hormone, atropine, methamphetamine, potassium, and calcium (*1*). It is the purpose of this report to describe the differential effects of injections of reserpine (*2*) on the conditioned responses.

When either the latency of the conditioned avoidance response or the failure of the animal to respond to the condi-

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

Table 1. Comparison of performance in approach and avoidance situations for each cat following intramuscular injection of reserpine. All figures are percentages.

Responses	Cat							
	A	B	E	F	G	H	K	L
Avoidance								
Correct	29	47	67	71	29	82	53	31
Escape	10	25	4	18	10	8	8	21
No response	61	28	29	11	61	10	39	48
Pattern								
Correct	76	100	83	93	63	82	81	83
Error	9	0	0	7	12	0	4	3
Food only*	0	0	0	0	12	11	13	0
No response	15	0	17	0	13	7	2	14

* The cat approached and ate visible food but refused to approach patterns.

tioned stimulus was used as the index, it was found that reserpine affected the conditioned avoidance response to a visual cue much more severely than it affected the same response to an auditory cue. Friedman two-way analysis of variance (*3*) showed that this visual-auditory differential is significant at better than the 0.01 level. An extreme illustration of the differential is shown in Fig. 1. Since these responses were learned by two subgroups in counterbalanced order, it is possible to demonstrate that this differential susceptibility is not related to order of acquisition. It is related to the difficulty of learning the two responses, for avoidance to tone was acquired in fewer trials regardless of the order of learning. With sufficiently large doses of reserpine it was possible to block the avoidance responses to both stimuli, but examination of the time course of effects shows that the visually cued response is affected earlier and usually recovers later than the response to the auditory stimulus.

At times, when presentation of the conditioned stimulus did not elicit the conditioned avoidance response, a cat that had been injected with reserpine could be seen to cringe, growl, and sometimes attempt to escape from the box, on occasion even climbing to the ceiling of the compartment. These observations can be interpreted as evidence that the sensory mechanisms necessary for perception of the stimuli are functional and that the motor capacity of the animals to make the conditioned response is unimpaired. The adequate performance of a conditioned avoidance response to one stimulus but not to another, although the latter was followed by arousal and apparently affective reactions, suggests that the reserpine has not blocked what we might term the "anxiety-evoking potential" of the conditioned stimulus. The dosage levels used throughout these experiments were appreciably lower than those generally reported in current psychopharmacological investigations of reserpine, ranging from 7.5 to 65 μg/kg for intramuscular administration and from 25 to 300 μg total dose for central administration. Clear behavioral effects were demonstrated with doses as low as 7.5 μg/kg (intramuscular administration). The failure of Weiskrantz and Wilson (*4*) to find an analogous split between their approach and avoidance situations may be attributable to their excessively high doses (0.75 mg/kg) of reserpine, which resulted in a total behavioral depression.

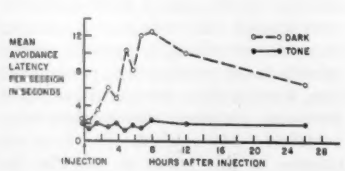

Fig. 1. Mean latency in seconds for avoidance responses to two different conditioned stimuli in one cat following central injection of 200 μg of reserpine (total dose).

Examination of the effects of reserpine on conditioned avoidance responses and on pattern discrimination for food shows a definite difference. Table 1 shows results based on 730 trials in shock avoidance and on 355 trials in pattern discrimination after intramuscular injection of reserpine (*5*). The two distributions of percentages of correct trials differ at slightly better than the 0.01 level, according to the sign test (*3*). This difference is not related to ease of acquisition in terms of trials to criterion. All cats showed such a split in behavior regardless of whether they learned pattern discrimination more or less quickly than they learned avoidance. These data suggest that reserpine affects behavior acquired under motivation from punishment more readily than it affects behavior reinforced by reward. It is true that the responses differ along other dimensions than that of approach versus avoidance but the data of Grastyán *et al.* (*6*) suggest that this may represent a basic physiological dichotomy (*7*).

The retention, under reserpine, of a visually mediated approach response simultaneously with the blocking of a visually cued avoidance response further demonstrates that the visual pathways remain functional during the period in which the animal is affected by reserpine.

It is felt that the data cannot be reconciled with the interpretation that reserpine at these doses blocks the conditioned avoidance response by interference with sensory perception, with motivation to perform, or with motor coordination. Therefore we propose that this selective action of reserpine may be attributeu to an interference with the specific conditioned association between the stimulus and a directed evasion response—that is, interference with learned associations (*8*).

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1. Detailed reports on these studies are in preparation.
2. We wish to express our thanks to Dr. Jurg Schneider of Ciba Pharmaceutical Products Inc. for supplying us with reserpine (Serpasil).
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5. Comparable data from central injections are not given here because of their sporadic nature, which is due to the fact that the placebo material in which reserpine is dissolved tends to destroy appetite when it is centrally injected. We were not aware of this phenomenon until we injected the placebo alone.
6. E. Grastyán *et al.*, *Kisérletes Orvostudomány* 9, 88 (1957).
7. Experiments are in progress to clarify whether or not it is the motivational dimension which is crucial to this distinction.
8. The research reported here was carried out with the support of the National Science Foundation (grant No. G-3354).

5 August 1957

Colorimetric Assay for Dipicolinic Acid in Bacterial Spores

Dipicolinic acid (pyridine 2,6-dicarboxylic acid) is a major component of bacterial spores (*1, 2*) and is unique in that it has been found only in such spores. It is synthesized during sporulation. The spores release dipicolinic acid during germination (*1*), or upon hydrolysis (*2*) or heating (*3*). Methods of analysis so far published (*2, 4*) are based upon ultraviolet absorption of the compound after acid digestion of the spores, isolation of the dipicolinic acid by ether extraction, paper chromatography of the extract, and elution of the acid-bearing spots. Though accurate, this method is extremely time-consuming and laborious. This report (*5*) describes a more convenient colorimetric method that

utilizes the color complex formed by interaction of ferrous iron with dipicolinic acid (*6*).

The complex of ferrous iron and dipicolinic acid which is prepared from the authentic dipicolinic acid described by Black, Depp, and Corson (*7*) is unstable, but the addition of a reducing agent such as ascorbic acid yields a complex that is stable for at least 2 hours. Maximum color develops in a *p*H range of from 4.0 to 6.0. In more acidic solutions, the color is diminished, and in slightly alkaline solution, precipitation occurs. Figure 1 shows the linear relationship between the optical density at 440 mμ and concentrations over a range from 30 to 160 μg/ml.

For the colorimetric assay of dipicolinic acid in spores, 5 ml of a spore suspension of *Bacillus cereus* (ATCC 10702) (in a 15- by 125-mm test tube) containing 4 to 20 mg of spores (dry weight) is autoclaved for 15 minutes at 15 lb/in². The suspension is cooled, acidified with 0.1 ml of 1.0*N* acetic acid, and left at room temperature for 1 hour, during which time aggregation of the insoluble material occurs. Upon centrifugation at 1500*g* for 10 minutes, a clear supernatant is obtained. If the initial suspension contains an appreciable number of vegetative cells, it may be necessary to increase the amount of acetic acid in order to obtain a clear solution. Four milliliters of supernatant are carefully pipetted into a clean 15- by 125-mm test tube. With a pipette controller, the extract can easily be removed without disturbing the sediment. One milliliter of freshly prepared reagent, consisting of 1 percent of $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$ and 1 percent of ascorbic acid in 0.5*M* acetate buffer at *p*H 5.5, is added to the 4 ml of supernatant. The color develops immediately, and the optical density should be measured within 2 hours. The blank is a similarly treated suspension in which 1 ml of water is substituted for the color reagent. The reagent blank is negligible. The standard is prepared by adding 1 ml of the color reagent to 4.0 ml of an aqueous solution containing 100 μg of dipicolinic acid per milliliter.

Determinations of dipicolinic acid by ultraviolet absorption and by colorimetric methods gave results which were in close agreement. Free dipicolinic acid was measured in an aqueous suspension of dried spores, as described by Krishna Murty and Halvorson (*4*). An ether extract of the suspension was chromatographed on paper, the spots containing dipicolinic acid were eluted, and the ultraviolet absorption of the eluate was measured at 270 mμ, with a Beckman DU spectrophotometer. This assay showed 41.6 μg of dipicolinic acid per milligram of spores. An aliquot of the same spore suspension assayed by the colorimetric method showed 42.3 μg of dipicolinic acid per milligram of dried spores.

Although divalent iron will react similarly with other α-carboxy pyridine compounds (*6*), the agreement in results between this method and the ultraviolet absorption method, which includes isolation of the dipicolinic acid, indicates that, for spore preparations, the assay is specific. Furthermore, no other α-carboxy pyridine compounds have been reported in spores. The addition of authentic dipicolinic acid to vegetative cell preparations yielded quantitative recovery of the dipicolinic acid upon assaying by the colorimetric method. This shows that vegetative cells contain neither components that interfere with the assay nor nonspecific compounds that assay as dipicolinic acid.

Other ions, including manganese and calcium, will complex with dipicolinic acid, but in the preparations studied no effective competition of these ions with the ferrous iron has been observed. In preparations in which the concentration of these ions is excessive, the interference can be overcome by increasing the concentration of the iron in the color reagent.

Autoclaving was found to release essentially all the dipicolinic acid of the spores. By colorimetric assay, we compared the dipicolinic acid released from a preparation of dried spores by autoclaving with that released by acid digestion in 3*N* HCl for 15 minutes. The amounts were 42.3 and 43.0 μg/mg, respectively. When the washed residue of the autoclaved suspension was digested in acid, an additional 0.45 μg of dipicolinic acid was recovered.

The data for the standard curve (Fig. 1) were obtained by means of a Beckman DU spectrophotometer, but all routine colorimetric assays were made with a line-operated spectrophotometer. The local line fluctuations were such that the probable error of replicate optical density readings at times exceeds 2 percent.

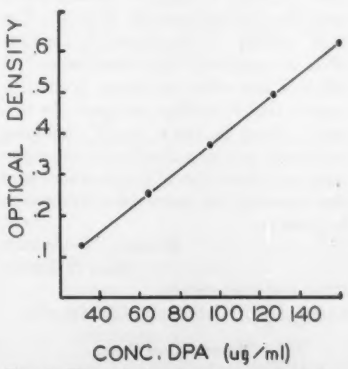

Fig. 1. The relation between optical density and dipicolinic acid concentration. Optical density was measured at 440 mμ with a Beckman DU spectrophotometer.

Under such conditions, no significance can be ascribed to the differences in results obtained with the two methods or to the trace of dipicolinic acid observed on the residues from the autoclaved preparation in the last experiment described.

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23 September 1957

Evidence for a New Growth-Promoting Acid Produced by Lactobacillus casei

Lactobacillus casei 280-16 (or 280-16A) requires either D-lactic acid or any one of a number of other D-α-hydroxy fatty acids for optimal growth (*1*, *2*). Yeast extract serves as a source of D-α-hydroxy acid for this organism, and at least part of its nutritional activity is attributable to D-lactic acid (*1*). Culture filtrates of *L. arabinosus*, *L. casei* (hydroxy acid-independent strain), *Leuconostoc mesenteroides*, *Lactobacillus brevis*, and *L. fermenti* have also been shown to provide growth promoting material assumed to be D-lactic acid (*1*). The present investigation (*3*) reveals, however, that the growth stimulant to be found in cultures of *L. casei* is not D-lactic acid, but a more lipophilic acid, possibly a higher homolog of D-lactic acid.

Lactobacillus casei 280-16A and its hydroxy acid-independent parent (American Type Culture No. 7469) were incubated at 35°C for 72 hours in a medium free of hydroxy acid. The hydroxy acid deficiency of this medium was overcome, in the case of the hydroxy acid-dependent strain, by employing a very heavy inoculum, yielding an initial population of approximately 3×10^8 cells per milliliter of medium. The nearly normal growth which resulted under these conditions was probably due to D-α-hydroxy acids carried either in or on the washed cells. An equally dense initial population was introduced in the case of the hydroxy acid-independent strain, al-

though normal growth of this organism could have been initiated with a very much smaller inoculum.

The cultures were clarified by centrifugation, acidified by adding 2 ml of concentrated sulfuric acid to each, and steam-distilled to remove volatile acid. Titratable acid, amounting to 165 and 230 μequivalent/ml of culture, was produced by the dependent and independent strains, respectively. Acidity lost during steam distillation amounted to 140 and 138 μequivalent/ml, respectively, for the two cultures (*4*). Ammonium sulfate and sulfuric acid were added to the residual cultures to make each final solution 1*N* with respect to sulfuric acid and 30 percent with respect to ammonium sulfate. Each solution was then extracted with seven consecutive 15-ml portions of isopropyl ether-butanol mixture (2/1 by volume), and titratable acidity and growth-promoting activity were determined in a 1-ml aliquot of each extract.

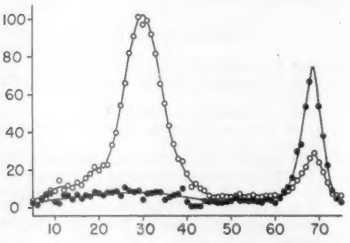

Fig. 1. Distribution of titratable acid (open circles) and growth-promoting activity (solid circles) in extracts of a *Lactobacillus casei* 7469 culture after 70 transfers in the following solvent system: upper phase isopropyl ether-butanol 2/1 by volume; lower phase 30 percent ammonium sulfate in 1*N* sulfuric acid. The values on the vertical scale represent either microequivalents of titratable acid (open circles) or units of growth-promoting activity (defined in Table 1) (solid circles) in the upper-phase solution (10 ml) of each cell. The numbers on the horizontal scale designate the consecutive cells of the counter-current extraction apparatus. The seven extracts of the *L. casei* 7469 culture (Table 1) were combined, evaporated nearly to dryness under reduced pressure, dissolved in 50 ml of upper-phase solvent, and distributed, 10 ml per cell, into cells 4, 5, and 6 at the outset of the counter-current extraction.

Table 1. Titratable acid and growth-promoting activity in extracts of cultures of *Lactobacillus casei*.

Extract No.	Strain 280–16A		Strain 7469	
	Titratable acid* (meq)	Growth-promoting activity (units)†	Titratable acid (meq)	Growth-promoting activity (units)
1‡	0.64	< 4	0.85	169
2	1.09	< 7	1.32	244
3	1.05	< 7	1.24	124
4	0.93	< 7	1.19	87
5	0.90	< 7	1.17	60
6	0.88	< 7	1.15	46
7	0.86	< 7	1.12	38

* Calculated from titrations with 0.01*N* sodium hydroxide. Phenolphthalein indicator, used with extracts 1 through 3 of the 280–16A culture, was replaced with brom thymol blue indicator for the remaining extracts of both cultures since the latter gave a sharper end point (but somewhat low titration values).

† One unit of growth-promoting activity is an amount equivalent to the growth-promoting activity 1 μmole of D-lactic acid (used as standard in the microbiological assays).

‡ During the first extraction, part of the nonaqueous solvents dissolved in the aqueous phase, and for this reason the first extract was smaller in volume and otherwise is not directly comparable to the subsequent extracts.

The results, shown in Table 1, make it fairly evident that growth-promoting activity is not associated with the major fraction of titratable acid, which appears, as would be expected, to have the correct distribution coefficient for lactic acid (0.6 in this solvent system, according to the results of a preliminary experiment with the purified compound) in either culture. That essentially none of the growth-promoting activity produced by the independent strain is associated with lactic acid is evident from the data obtained by counter-current extraction of three-fifths of the remaining combined extracts from the culture medium of this organism (Fig. 1). The solvent system employed for this extraction (carried through 70 transfers) was the same as that for the preliminary extraction. It may be seen (Fig. 1) that the distribution of the major titratable component distribution coefficient, 0.56) is close to that which could have been predicted from the distribution coefficient of lactic acid. A much smaller component (distribution coefficient, 10.6) is seen to be associated with the growth-promoting activity (Fig. 1). That this growth-promoting material was not formed artifactitiously is evident from its absence in the extracts of the dependent culture, which was treated as a control (Table 1). The growth-promoting potency of the active component appears to be about three times that of D-lactic acid when growth-promoting units (defined in Table 1) are compared with titration equivalents (Fig. 1). The high activity of the material, together with its relatively high distribution coefficient and other solubility properties, suggest that it is either a higher (by several carbons in chain length) homolog of D-lactic acid or a closely related analogous acid. Isolation of larger amounts of this material for exact identification is in process.

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3. This investigation (No. 120) was aided by grants from the National Multiple Sclerosis Society, the U.S. Public Health Service, and the University of California. We are indebted to Evelyn Brown and Audree Fowler for technical assistance.

4. The calculated acetic acid content of the acidified cultures was 146 μequivalent/ml derived from sodium acetate included in the medium. It appears, therefore, that 94 to 96 percent of the available acetic acid was removed by the steam distillation. Probably only negligible amounts of lactic acid and growth-promoting acid, if any, were removed by this process.

4 October 1957

Induction of Enzymes of the Galactose Pathway in Mutants of Saccharomyces cerevisiae

Induced biosynthesis of enzymes is dependent on the presence of a stereospecific inducer, which is not necessarily a substrate (*1*). In *Pseudomonas* it was shown that a sequential adaptation of a series of enzymes of a metabolic pathway takes place in the presence of the first (or often an intermediary) substrate of a chain of inducible enzymes (*2*). In the pathway

$$A \xrightarrow{\text{I}} B \xrightarrow{\text{II}} C \xrightarrow{\text{III}} D$$

enzyme II will arise in response to the formation of product *B*, and enzyme III will be formed when product *C* accumulates, and so forth.

In the present study (*3, 4*) the inducible properties of the enzymes of galactose metabolism are considered in relation to the problem of sequential induction. The formation of these enzymes in response to galactose cannot be explained in terms of this pattern.

The galactose pathway (the old "galactozymase complex") which effects the complete transformation of galactose to glucose has now been completely established (*5–8*) and can be summarized as follows (*4*):

$$\text{Galactose} + \text{ATP} \xrightarrow{\text{galactokinase}} \text{Gal-1-P} + \text{ADP} \quad (1)$$

$$\text{Gal-1-P} + \text{UDPG} \underset{\text{Gal-1-P uridyltransferase}}{\rightleftharpoons} \text{UDPGal} + \text{G-1-P} \quad (2)$$

$$\text{UDPGAL} \underset{\text{(DPN)}}{\overset{\text{UDPGal-4-epimerase}}{\rightleftharpoons}} \text{UDPG} \quad (3)$$

Sum: $\text{Galactose} + \text{ATP} \rightleftarrows \text{G-1-P} + \text{ADP}$

The initial formation of the catalytical amount of uridine diphosphoglucose necessary to start reaction 2 is provided by a fourth reaction:

$$\text{UTP} + \text{G-1-P} \underset{\text{UDPG pyrophosphorylase}}{\rightleftharpoons} \text{UDPG} + \text{PP} \quad (4)$$

In the present study two haploid mu-

tants of *Saccharomyces cerevisiae* which are not able to ferment galactose were used (*9*). One of the mutants was considered to be galactokinaseless (genotype g_1G_2 (*10*), while the other one is apparently defective in a system involved in the transport of galactose (genotype G_1g_2) (*11*).

The activities of the enzymes involved in the galactose pathway were determined by means of recently developed methods (*8, 12, 13*).

Galactokinase activity was found to be present in G_1g_2 cells when it was induced by galactose, but it was always completely absent in g_1G_2 cells (see Table 1). These results are in complete agreement with the finding that, in yeast, the galactokinase activity is under the control of the gene G_1. The role of the G_2 gene in the "active transport" of galactose is under investigation.

By the addition of galactose either to the cells growing on glucose-salts medium or to cells suspended in buffered acetate solution, a very striking synthesis of the galactose enzymes takes place even in the galactokinaseless mutant (see Table 1). Although α-galactose-1-phosphate, the normal substrate for α-galactose-1-phosphate uridyl transferase, is not formed, or at least not in detectable amounts, this enzyme and the subsequent enzyme, uridine diphosphogalactose-4-epimerase, are nevertheless induced. The absence of uridine diphosphogalactose-4-epimerase in unadapted yeast was unexpected, since uridine diphosphoglucose, the other substrate for this enzyme, is always present (*6*). The fact that the α-galactose-1-phosphate uridyl transferase was induced without the formation of any detectable amount of its substrates was also contrary to expectation; with techniques developed in this laboratory (*12*), less than 0.0002 μmole of α-galactose-1-phosphate or uridine diphosphogalactose formed per milligram of protein per hour could have been detected.

It is, therefore, difficult to explain the observed phenomena on the basis of sequential adaptation unless one assumes that a few molecules of α-galactose-1-phosphate are able to induce α-galactose-1-phosphate uridyl transferase. Furthermore, an even smaller number of uridine diphosphogalactose molecules would, in turn, induce the uridine diphosphogalactose-4-epimerase. A more reasonable hypothesis is that free galactose itself acts as the "gratuitous," and multi-, inducer of the biosynthesis of two successive enzymes of the galactose pathway in the galactokinaseless mutant. A more detailed paper describing additional data which support this hypothesis is in preparation.

It should be emphasized that in the present case galactose appears to initiate the induction of at least three enzymes, catalyzing entirely different types of reactions: galactokinase, catalyzing phosphorylation of the reducing group of galactose; α-galactose-1-phosphate uridyl transferase, catalyzing the transfer of a uridyl group; and uridine diphosphogalactose-4-epimerase, catalyzing an inversion. Free galactose has already been shown to be an inducer for β-galactosidase (*14*) and β-galactoside permease (*15*) in *Escherichia coli*.

A number of other pentoses and hexoses have been tried, but thus far only galactose has been found to serve as an inducer.

Note added in proof: After the present paper was submitted, Mills *et al.* reported that uridine diphosphogalactose-4-epimerase is present in unadapted *Saccharomyces fragilis* [*Biochim. et Biophys. Acta*, 25, 521 (1957)]. We repeated the same type of experiments reported here, but used *S. fragilis*, and the results, in complete agreement with the present findings with *S. cerevisiae*, show that uridine diphosphogalactose-4-epimerase cannot be detected in unadapted yeasts.

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4. The following abbreviations are used: ADP and ATP, adenosine di-, and tri-, phosphate, respectively; Gal-1-P, α-galactose-1-phosphate; G-1-P, α-glucose-1-phosphate; UDPG; uridine diphosphoglucose; UDPGal, uridine diphosphogalactose; PP, inorganic pyrophosphate; UTP, uridine triphosphate.
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16. The culture medium contained, per liter: $MgSO_4$, 1.4 g; KH_2PO_4, 2.0 g; NaCl, 1.0 g; $(NH_4)_2SO_4$, 7.0 g; $CaCl_2$, 0.8 g; $FeCl_3 \cdot 6H_2O$, 0.4 g; *l*-tryptophan, 10.0 mg; *l*-methionine, 10.0 mg; *l*-histidine HCl, 10.0 g; glucose, 5.0 g. Galactose was added, when indicated, from the beginning of the growth.
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17 September 1957

Table 1. Specific activities of "galactose enzymes" in an uninduced and induced galactokinaseless strain of *Saccharomyces cerevisiae*. Cells were grown aerobically for 48 hours at 25°C in glucose synthetic medium (*16*) (with and without galactose); activities were determined on a dialyzed "Nossal" (*17*) extract; substrates for steps 1, 2, 3, and 4 were galactose, Gal-1-P, UDPGal, and UDPG, respectively.

Galactose in growth medium (mg/ml)	Specific activity [(μmole × 10^{-4})/(min × mg)]			
	Galactokinase (step 1)	Gal-1-P uridyl transferase (step 2)	UDPGal-4-epimerase (step 3)	UDPG pyrophosphorylase (step 4)
0	0	0.1	0	91.7
1	0	89.6	57.0	125.0

Apparent Shifts of Absorption Bands of Cell Suspensions and Selective Light Scattering

Absorption spectra of cell suspensions are usually determined by the measurement of transmitted light beams. Cell suspensions attenuate an incident beam in two ways—by absorption and by scattering. The effect of scattering is almost always of the same order of magnitude as that of absorption. It is generally assumed that scattering varies gradually and uniformly with wavelength and that it therefore does not greatly alter the positions and shapes of absorption bands. Recently, however, it was found that pigmented algal cells scatter light with a strong spectral selectivity (*1*). Sharp scattering peaks occur on the long wavelength sides of the major absorption bands. The experiments described in this report were carried out to determine whether light scattering can seriously distort the absorption spectra of cells (*2*).

Absorption spectra of a suspension of the green alga *Chlorella pyrenoidosa* were measured in two different ways, one designed to maximize, the other to minimize, the influence of scattering. Both measurements were made with a Beckman DK-2 recording spectrophotometer.

Three possible arrangements of the optical system are shown in Fig. 1. Arrangement *a* is the usual one. The photocell is so far from the sample that it collects only light transmitted directly and that scattered within about ±3 de-

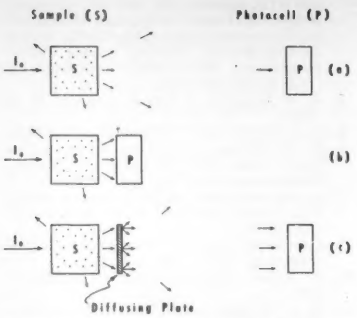

Fig. 1. Schematic diagrams of part of optical system of spectrophotometer.

grees. This arrangement gives an absorption spectrum which is the one most severely influenced by scattering. Arrangement *b* permits the photocell to collect light scattered angles up to about 30 to 50 degrees. Arrangement *c*, suggested by Shibata *et al.* (*3*), is equivalent to *b* with respect to the collection of scattered light and is experimentally more convenient. A diffusing plate, inserted behind the sample, causes a small but representative part of the light striking it to enter the photocell. Arrangement *c*, with identical diffusing plates made of opal glass placed behind the sample and the blank vessel, was used to minimize the influence of scattering.

The only spectrophotometer settings which were different for the two arrangements were those for the amplification of the photocell response and the band halfwidth (5 mμ for *a* and 7 mμ for *c* at a wavelength of 690 mμ; less at shorter wavelengths). Controls indicated that these differences did not influence the results. As a further check of the instrument and method, absorption spectra of chlorophyll in acetone were measured with arrangements *a* and *c*. The shapes and positions of the bands on the two curves were identical, but the absorption between the bands differed slightly, probably because of multiple reflections between the diffusing plate and the sample vessel.

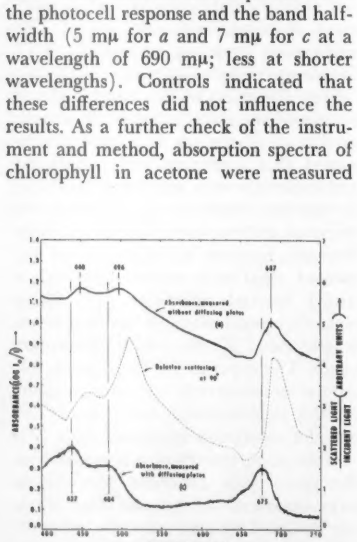

Fig. 2. Absorption spectra of *Chlorella*, measured with Beckman DK-2 recording spectrophotometer; arrangements *a* and *c* (shown in Fig. 1) were used. Both absorption curves are reproductions of original spectrophotometer recordings, each of which was made in triplicate. Center curve: scattering by *Chlorella* at 90 degrees. [From P. Latimer and E. Rabinowitch (*1*)]

Figure 2 shows the absorption curves of a *Chlorella* suspension (10^{-3} ml of cells per milliliter) obtained with arrangements *a* and *c* and also the previously reported scattering curve of this organism. The latter curve is for light scattered at 90 degrees but is qualitatively representative of light scattered at most angles.

Of particular interest are the differences of more than 10 mμ between the positions of the major bands on the two absorption curves. Similar differences are found in the absorption curves published by Shibata *et al.* (*3*); however, these authors emphasized only the sharpness of the absorption bands as measured with diffusing plates and did not draw attention to the differences in the positions of the peaks.

Curve *c* is in reasonably good agreement with other absorption spectra reported for *Chlorella* (*1, 3, 4*); presumably the positions and shapes of the bands on it are approximately correct. The bands on curve *a*, however, seem to represent the *sum* of the scattering bands and the absorption bands (on curve *c*) of *Chlorella* which occur at different wavelengths. Light interference effects, such as those observed by Lothian and Lewis (*5*) in similar studies of red blood cells, may also have contributed to the differences between our "absorption" curves. Neither mechanism by itself can explain all related experimental results that have been reported to date. However, the asymmetry of the distorted absorption bands on curve *a* about the actual absorption maxima on *c* indicates that anomalous dispersion, which is also asymmetrical about absorption bands and which causes selective scattering, is of primary importance.

We are investigating the effects of scattering with a special spectrophotometer that allows the making of measurements of light transmitted or scattered at different angles. Some of the results, which confirm those shown in Fig. 2, should be useful in interpreting this distortion phenomenon.

Chlorella cells of the same strain but from other cultures gave quantitatively different results. While the red absorption maximum of all cells occurred at 675 mμ on the *c* curves, the position of this maximum on the *a* curves varied, with the culture, from 683 mμ to 691 mμ. The bands at the longest wavelengths were obtained with the cells which appeared to be in the rapid growth phase.

We also measured pairs of absorption curves for suspensions of chloroplasts and very small chloroplast fragments (*6*). The chloroplasts (average dimension 5 to 6 μ) gave a curve like some of those of *Chlorella*. The suspension of small fragments, however, behaved more like chlorophyll in solution; its bands on curves *a* and *c* were identical in shape and position.

The optical effect described here can significantly distort the positions and shapes of absorption bands of cells and their components. Some published absorption spectra of cells may show the influence of this effect. The influence would vary with the optical system of the spectrophotometer and with the scattering characteristics of the particular suspension.

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6 November 1957

Effect of Reserpine and Promazine on Diphosphopyridine Nucleotide Synthesis in Liver

It has been found by Kaplan *et al.* that the injection of nicotinamide into mice results in large increases of the levels of diphosphopyridine nucleotide (DPN) in tissue (*1*). The administration of "tranquilizing" agents, such as reserpine (*2*) and promazine (*3*), prior to the injection of nicotinamide results in the level of DPN in the liver being maintained at an elevated concentration for a prolonged period of time. This report (*4*) presents details of this observation and discusses some of their implications.

Hybrid male mice [(BALB/c An × DBA/2J)F_1, 8 to 10 weeks old, of 20 to 25 g body weight] were divided randomly into groups. Reserpine was administered subcutaneously 4 hours prior to the intraperitoneal injection of nicotinamide. Animals were sacrificed by cervical fracture at different time in-

tervals following administration of the nicotinamide. The livers were removed rapidly, weighed, and homogenized in cold 5 percent trichloroacetic acid. Diphosphopyridine nucleotide analyses were performed, in accordance with a modification (*5*) of the procedure of Levitas *et al.* (*6*). Four control groups were prepared as follows: by administering (i) reserpine only, (ii) nicotinamide only, and (iii) vehicle (*7*), without reserpine, plus nicotinamide and (iv) by using untreated animals.

Typical data from these experiments are presented in Fig. 1. The line labeled "untreated control" represents the DPN concentration in micrograms per gram of tissue (wet weight) for categories iv and i (untreated mice and mice that had received reserpine alone). Administration of reserpine alone did not produce a detectable change of DPN levels in the liver when comparison was made with the untreated controls. The curve labeled "no reserpine" represents data obtained from the mice that had been given nicotinamide only or that had been given a vehicle (for reserpine) plus nicotinamide. As has been shown, the administration of 500 mg of nicotinamide per kilogram of body weight results in an increase in DPN concentration in the liver. The data presented show an increase from about 500 μg to almost 4000 μg per gram in the first 12-hour interval after administration. In all the animals examined, 24 hours after the injection of nicotinamide alone, the DPN level had returned to the basal level and remained constant over the next 24-hour interval. When reserpine was administered before injection of the nicotinamide, the rate of accumulation of DPN was slower, but the same peak concentration was observed. It may be seen (Fig. 1, curve labeled "reserpine 10 mg/kg") that the high DPN level was maintained over a considerable length of time, being twice the basal level even 48 hours after administration of the nicotinamide.

A dose-response relationship may be observed by comparing the curves representing data obtained from animals that had been pretreated with injections of reserpine of 10, 4, or 1.6 mg per kilogram and from those that had been given no reserpine. Similar results have been obtained with other compounds possessing "tranquilizing" properties, such as deserpidine (*2*), promazine, and chlorpromazine. Compounds related to reserpine and promazine which are not "tranquilizing" agents failed to maintain the elevated DPN level. Meprobamate, pentobarbital, and ethanol were ineffective, even though the doses used kept the animals in a comatose state. It is interesting to note that the amount of the chlorpromazine required to produce this effect on DPN synthesis was about 20 times the dose of reserpine administered.

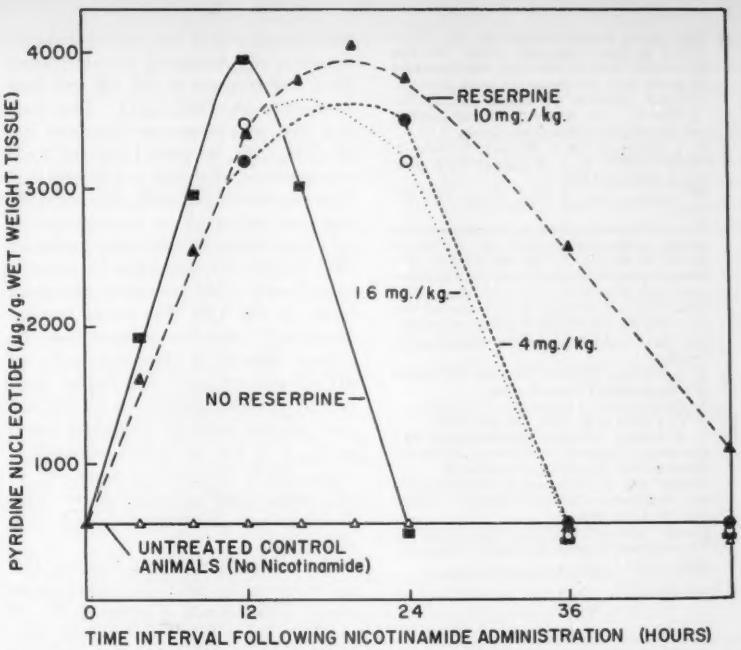

Fig. 1. Effect of reserpine upon the level of diphosphopyridine nucleotide in mouse liver. The experiment was conducted as described in the text. Open triangles, data obtained from untreated control animals and from animals that had received only reserpine; solid squares, data for animals that had received nicotinamide and nicotinamide-and-vehicle (*7*). Data from mice that had received injections of reserpine 4 hours prior to the injection of nicotinamide are indicated by the following symbols: solid triangle (10 mg/kg), solid circle (4 mg/kg), open circle (1.6 mg/kg). Each experimental point represents the average value obtained from three animals.

It is of interest to consider some possible implications of these results. First, the relationship between reserpine or chlorpromazine and the tissue DPN level following administration of nicotinamide suggests that the pyridine nucleotide may be implicated in the mechanism of action of these "tranquilizing" drugs. If a mechanism for the action of "tranquilizing" agents does involve DPN, then it may be possible to demonstrate synergism between the "tranquilizing" agent and nicotinamide. Preliminary behavioral evidence in man obtained by C. Kornetsky suggests such a relationship (*8*).

Second, in view of the recent demonstration that reserpine is an antileukemic agent (*9*) and that an analog of nicotinamide, 3-acetylpyridine, will form the corresponding analog of DPN in neoplastic tissue (*10*), it would be of interest to know whether or not nicotinamide enhances reserpine antitumor activity or whether reserpine can facilitate the formation of the DPN analog in tumor tissue. Such studies would be of practical importance in studying the mechanism of action of reserpine as an antileukemic agent.

Third, little is known of the enzymatic pathways of the synthesis of DPN. The use of agents such as reserpine and promazine may be of considerable value in elucidating the individual enzymatic steps. Since the extent of DPN synthesis was not appreciably affected by administration of reserpine, the action of the drug may be directed through the DPN-splitting enzymes. It has been found, however, that reserpine does not inhibit the breakdown of DPN by mouse-liver homogenates. This suggests that the tranquilizer does not act directly on the DPN cleavage enzymes (*11*).

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3. We wish to thank the Wyeth Institute for Medical Research for the gifts of the phenothiazine derivatives and the meprobamate (Equanil).

4. This report is contribution No. 200 of the McCollum-Pratt Institute, Johns Hopkins University. Part of this work was supported by grants from the National Cancer Institute, National Institutes of Health (grant No. C-2374 C), the American Cancer Society, and the American Heart Association.
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24 September 1957

Purification and Properties of an Interstitial Cell-Stimulating Hormone from Sheep Pituitaries

Two groups of investigators have previously reported procedures for the isolation of interstitial cell-stimulating hormone (ICSH) from both sheep (*1*) and swine pituitary glands (*2*). Recently, reexamination of these procedures has led us to the development of a new method utilizing some of the newer techniques for purification of proteins that have been developed since the earlier purifications were described. In the course of this work, it was noted that more than one protein component in the extract from sheep pituitaries possesses ICSH activity. Moreover, one of these active components, the isolation of which is described herein, has properties different from those reported for either of the earlier preparations (*1*, *2*).

Acetone-desiccated sheep pituitaries (1 kg) were extracted (*3*) with a 0.5 percent NaCl solution at *p*H 4.6. The extract was adjusted to *p*H 7.15, and ethanol was added at −15°C until the concentration of ethanol reached 40 percent by volume. The resulting precipitate was extracted with water at 0°C, and the insoluble portion was removed by centrifugation. Solid NaCl and a 0.2*M* sulfosalicylate buffer (*p*H about 3.6) were added to the supernatant fluid to give a final concentration of 0.15*M* with respect to sodium chloride and 0.02*M* with respect to sulfosalicylate. The *p*H was then adjusted to 3.60 ± 0.03 by addition of 1*M* HCl. The precipitate that formed was of low activity and consequently was discarded; the supernatant fluid was adjusted to *p*H 6.9 and fractionated with $(NH_4)_2SO_4$. The fraction that precipitated at concentrations of $(NH_4)_2SO_4$ between 1.3*M* and 2.1*M* was collected, dialyzed, and lyophilized. This fraction (designated as fraction B) was next subjected to chromatography on a polycarboxylic acid resin, Amberlite IRC-50 (XE-97), which had been equilibrated with 0.2*M* potassium phosphate buffer of *p*H 5.88. The active fraction (fraction C) which was eluted from the column with 0.2*M* phosphate buffer of *p*H 6.9 was recovered and further purified by chromatography on an IRC-50 resin column under the conditions shown in Fig. 1. It was noted that materials in tubes 126 to 143 and in tubes 144 to 159 were equally active; these were designated as fractions D-2 and D-3, respectively.

Further purification of fraction D-3 was achieved by zone electrophoresis on starch. The contents of segments No. 19 to 29 (fraction E-3, Fig. 2) were combined, and the protein was recovered and subjected again to chromatography on IRC-50 resin under the same conditions as those shown in Fig. 1. The active fraction (obtained in a yield of 65 mg/kg of pituitary glands) obtained in this manner behaves as a homogeneous protein according to chromatography on IRC-50 resin and carboxymethyl cellulose columns, in zone electrophoresis on starch, in boundary electrophoresis by the conventional method, and in the ultracentrifuge. It represents one of the ICSH-active components in the glandular extract and is hereafter designated as β-ICSH.

The interstitial-cell stimulating activity of β-ICSH was estimated by its ability to increase the weight of the ventral prostate in hypophysectomized rats (*4*). It was found that a total dose of 0.002 mg causes an increment of ventral prostate weight of from 8.5 to 18.6 mg when it is injected intraperitoneally over a period of 4 days into 23-day-old hypophysectomized rats (Long-Evans strain, 2 days postoperatively). It is essentially free from lactogenic, somatotropic follicle-stimulating, thyrotropic, and adrenocorticotropic activities.

The highly purified β-ICSH was subjected to biophysical investigation. The electrophoretic mobility was determined at 1°C in buffers of 0.1 ionic strength over a wide range of *p*H by means of the free boundary technique. At *p*H 4.2 in acetate buffer, the mobility was found to be $+1.84 \times 10^{-5} cm^2 sec^{-1} v^{-1}$; the isoelectric point was at *p*H 7.3. The sedimentation constant and diffusion coefficient were measured in a buffer consisting of 0.010*M* K_2HPO_4, 0.010*M* KH_2PO_4, and 0.200*M* NaCl. The respective values, corrected to zero protein concentration and 20°C, were found to be $s^0_{20} = 2.47$ *S* and $D^0_{20} = 7.54 \times 10^{-7} cm^2 sec^{-1}$. From these constants, together with an assumed value for partial specific volume (0.73 ml/g) and a solvent density of 1.010, the molecular weight of β-ICSH was computed to be 30,000. Chemical characterization of β-ICSH is in progress (*5*).

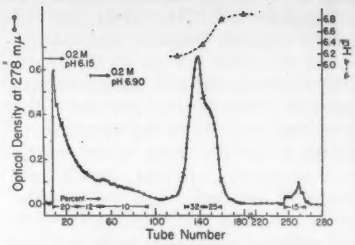

Fig. 1. Chromatography of fraction C on IRC-50 resin. One and two-tenths grams of the fraction was applied to the column containing 33 mg of resin equilibrated with 0.2*M* potassium phosphate at *p*H 6.13. Elution with buffer of *p*H 6.9 was started at tube 43. The final peak, tubes 244 to 270, was eluted with 0.2*N* NaOH. Fraction D-2 was recovered from tubes 126 to 143, and fraction D-3 from tubes 144 to 159. Percentage of recovery of protein nitrogen is given above the corresponding tube numbers. The *p*H during elution of the peak is represented by a dashed line.

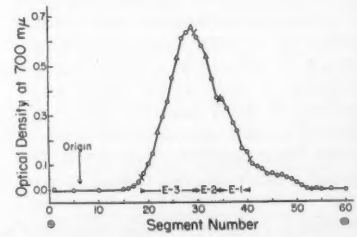

Fig. 2. Zone electrophoresis of 150 mg of fraction D-3 in acetate buffer of *p*H 4.2 and 0.10 ionic strength for 72 hours at 3.0 v cm^{-1}.

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23 October 1957

Book Reviews

The Price of Power. America since 1945. Herbert Agar. University of Chicago Press, Chicago, 1957. 200 pp. $3.50.

In *The Price of Power,* Herbert Agar is a publicist rather than a reporter, a painter rather than a photographer, and, I am tempted to say, a wise man rather than a scholar. A critic may say that, wise man or not, he cannot see the trees for the forest. There is no tree-by-tree analysis of the forest of American policy in the era of Truman and Eisenhower. Such detail as finds its way into this small volume is illustrative and symbolic; the result is clarification, not verification of Agar's main themes.

Progress toward ordering and understanding an apparent chaos of events and observations may not be so different in the world of science and the world of affairs as is generally assumed. It is by an alternation of brilliant hypothesis and meticulous investigation that truth can be approached, even though absolute truth can never quite be reached. Agar's intuitive, impressionistic effort to discover for Americans the inner meaning of our times is no substitute for patient historical research. It is, however, a storehouse of hypotheses which the historian may test in his detailed research. The historian has desperate need for such hypotheses if he is not to be the victim of America's office technology, which is producing records in a volume much greater than can be given even the most cursory future inspection.

The Price of Power is something else, too. It is a message by a participant-observer of momentous events and by an observer of great personages to his fellow-citizens. The book may, as the editor of *The Chicago History of American Civilization* suggests in the preface, become for future generations "itself a historical document," but the obvious intent of the author is to speak to his contemporaries. Agar's description of the great events of the postwar years can hardly be set down with the disinterested detachment of the astronomer who knows that by his observations he cannot alter the stars in their courses. As a publicist and editor, Agar is interpreting the immediate past in a way that he hopes will shape the immediate future.

As an avowed believer in internationalism, the right to nonconformity, and Presidential leadership, he has his heroes and his villains. Senator Vandenberg is the leading hero and Senator McCarthy the leading villain. For the rest, Agar stops far short of scorn for those with whom he disagrees and far short of idolatry for those whose goals he shares. Occasionally, his vignettes are as brilliant as they are balanced. Of President Truman in 1945, he wrote: "During the next few years this strange little man—lively and pert to the verge of bumptiousness; more widely read in history than any President since John Quincy Adams; more wilful than any President since James K. Polk; more incompetent in dividing the good from the bad among his own friends at home than any President since Warren Harding—would make and enforce a series of decisions upon which, for better or for worse, our world now rests, or shakes."

President Eisenhower may be surprised to learn from Agar that when he came to the Presidency he was "something far more old-fashioned and far more interesting than 'a good Kansas Republican': he was a Whig." Whigs believed in keeping the powers of the Presidency small; the most famous Whigs, Clay and Webster, were senators. "With General Eisenhower, for the first time, a President of great authority and popular appeal has carefully refrained from power." An alternative explanation for President Eisenhower's scrupulous unwillingness to exceed his constitutional powers is that as a general trained in a country with a strong tradition of civilian control, he has had a lifelong habit of acting only when his authority to act is not to be questioned.

Some of the American disappointment with the shape of the postwar world, Agar suggests, is of our own making. We need not have been so disillusioned with Soviet behavior if we had not persisted so long in our war-time illusions. Nor need we have embarked on the great McCarthyite witch-hunt if we had had the maturity to recognize that America was not all powerful. We would not then have had to resort to hunting for traitors at home in order to explain unpleasant events abroad.

Although Agar strikes a "two minutes to midnight" note in his closing paragraphs, in the body of his work he rejects alike the realistic pessimism of historical inevitability and the utopian pessimism of believing that nothing short of millenial reform can make the slightest difference. The price of power is constant, unremitting thought about how to use great but limited power to support world-wide and limitless goals.

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Glacial and Pleistocene Geology. Richard F. Flint. Wiley, New York; Chapman & Hall, London, 1957. xiii + 553 pp. Plates. $12.50.

This book follows essentially the same outline as Flint's *Glacial Geology and the Pleistocene Epoch,* published in 1947, but is slightly shorter. Roughly three-fifths of the text is devoted to characteristics of glaciers, to speculations about causes of glaciation, and to the various direct and indirect effects of glaciation; the balance is a treatment of Pleistocene stratigraphy, with emphasis on North America and Europe. A valuable bibliography of 866 titles is included.

Many of the subjects discussed in the earlier volume are brought up to date. Inclusion of such new topics as deep-sea sediments, frozen-ground phenomena, soils, and radiocarbon dating serves to emphasize the rapidly expanding scope of Pleistocene research during the last decade. A major addition is the presentation of stratigraphic information in the form of correlation tables, which doubtless will prove to be among the most controversial subjects in the book. Flint recognizes the obvious hazards in this choice and repeatedly warns that the unsatisfactory status of Pleistocene stratigraphic nomenclature and the numerous uncertainties involved in correlation render his present opinions extremely tentative. Names for substages of the last (Wisconsin) glaciation in central North America, which have been used for the last 25 years, are either rejected or relegated to the category of local usage, and no alternative general terminology is suggested. Flint correlates Pleistocene glaciations in several mountain ranges of western North America and also relates pluvial lake stages to mountain glaciation; however, he does not attempt to correlate mountain glaciation with con-

tinental glaciation, nor is there a correlation of continental glaciations in central and eastern North America. By contrast, the proposed correlations between various areas in Europe and between Europe and North America are quite detailed.

This book deserves, and doubtless will receive, widespread use as an introductory text. Students and professional geologists alike will appreciate Flint's efforts in compiling and succinctly summarizing useful information on nearly every facet of Pleistocene geology. Some readers may feel that the discussions of many subjects are entirely too brief. The fact is, however, that Pleistocene geology has grown so much that anything approaching an exhaustive treatment of the subject would no longer fit between the covers of a single volume.

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Functional Neuro-Anatomy. Including an atlas of the brain stem. A. R. Buchanan. Lea & Febiger, Philadelphia, ed. 3, 1957. 362 pp. Illus. $7.50.

This relatively small volume (259 pages of text and text figures) follows previous editions in attempting to present neuroanatomy in terms of functional systems rather than of anatomical levels. Ascending pathways in the spinal cord and brain stem, the special senses and their pathways, the cerebral cortex, voluntary motor pathways, the cerebellum, the basal ganglia, and the hypothalamus are discussed in that order; general introductory and closing chapters on such subjects as functional components of nerves and the blood supply of the central nervous system complete the text.

The book is simply and clearly written, with functional and anatomical aspects nicely interwoven, and is spiced by allusion to clinical conditions and practical applications. Appropriate references to the literature are included. The text figures, almost entirely line drawings, are likewise kept simple, to illustrate particular points rather than the over-all anatomy; they include many diagrams of conduction pathways. As one can expect in a third edition, slips of the tongue and typographical errors are at a minimum. The atlas consists of photographs of sections of one half of the brain stem with the other half shown in line drawing, and labeled; the location and direction of the section are shown on an accompanying diagram.

This is a book written specifically for an introductory course in neuroanatomy, and therefore it does not contain the detail that some teachers may demand in a text on this subject. I feel that the thalamus is somewhat slighted but regard the book as being otherwise well balanced. The student who uses this text should emerge with a clear understanding of the fundamentals of the structure and function of the central nervous system, and for this very basic reason it deserves the consideration of teachers in this field.

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Surgeons All. Harvey Graham. Philosophical Library, New York, ed. 2, 1957. 459 pp. Illus. $10.

Harvey Graham is the pseudonym of a well-known London physician and editor of medical publications, Isaac Harvey Flack. Another physician, the distinguished writer and poet Oliver St. John Gogarty, provides a foreword, in which he says, "This is the best book on surgery I have ever read. I agree with every word of it except the reasons for the removal of the Amazon's right breast." However, what sort of book it is, the reader might have difficulty in determining from the author's introductory matter, in which he expresses by implication surely the most extraordinary notions of the nature of historiography in his contention that "This is a story book: a story of surgery itself. . . . It is not a history book for it has not a solitary footnote and only the most meagre reference to original works," and "it was never intended for the Olympian few who read and enjoy such things."

Whether the presence of an *apparatus scholastici* or the direction of a work to the residents of Mount Olympus makes a history is immaterial; the fact remains that this work is a history of surgery in popular vein. Consequently, it must be judged by the standards of historical writing. However, I recognize that the point of view of the author is highly personalized, and so I am tempted to accept Graham's designation of the work as a "story" in the modern meaning given by the *Shorter Oxford English Dictionary* ("A narrative of real or, more usu., fictitious events, designed for the entertainment of the hearer or reader"), for the work is well and entertainingly written. Certainly the popular audience for whom it was intended will enjoy the general treatment of the subject, but as a history it is totally unreliable. It suffers, like all such works based almost exclusively upon secondary sources, in that the expressed opinions are based on information obtained at second or third hand, and, further, it tends to repeat the countless errors of detail derived unwittingly from the sources. Upon such foundations are built hagiology and mythology, not history. Dozens of errors of detail are observable, often minor but, in the mass, important. For example, the statement that Fallopius was a pupil of Vesalius is quite incorrect (incidentally on Fallopius' own testimony); this is a minor error, but the implications are important. Likewise, the observation, in reference to William Harvey (page 175), that "England knew nothing of many of the Italian anatomists, and thought but little of those few it had heard of," is absurd, as can easily be shown by reference to the contemporary English literature, and so denies the important influence which the Italian schools, especially Padua and Bologna, had on English developments.

Further, the author is often not well informed. For example, his account of Egyptian medicine is very misleading, since he depends in part on Bryan's translation from the German of Joachim's translation of *Papyrus Ebers*. Now Joachim's translation was made in 1890, as Ebbell has pointed out, at a stage in the development of Egyptology when this was far too risky an enterprise.

But a more serious criticism is the propriety of issuing a work which was published in the United States 18 years ago (as *The Story of Surgery*) without correction. The many errors pointed out by critics of the first edition remain uncorrected, save for a few mentioned in the secondary preface. The only new addition is a postscript which brings the work up to date by an assessment of the period 1939–1956. The author excuses himself on the grounds that, because the plates survived the bombing of London, the work could be reissued, without correction, at a modest price.

Nonetheless, the volume is a fascinating one, for it deals with a fascinating subject.

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The Development & Meaning of Eddington's 'Fundamental Theory'. Including a compilation from Eddington's unpublished manuscripts. Noel B. Slater. Cambridge University Press, Cambridge, 1957. xii + 299 pp. $7.50.

Eddington's posthumous work, *Fundamental Theory*, edited by the late Edmund T. Whittaker, appeared in 1953, nine years after the death of its author. The present work is apparently intended to serve a twofold purpose. To those readers who have attempted to read the original *Fundamental Theory* itself and have not succeeded, it presents a summary and an explanation of Eddington's ideas; it also throws additional light on

that book by drawing on earlier drafts and by reprinting fairly long excerpts where these deviate significantly from the 1953 published version.

Eddington's ideas have not found much favor with most professional physicists, and I must admit that even with the help of Slater's guide and Whittaker's lucid exposition in *From Euclid to Eddington* I find the going exceedingly rough. But Eddington was a man of very great vision indeed, and we cannot be certain that at some later stage in the development of physics we may not come back to some of his conceptions. Accordingly, I consider the publication of this guide worth while. As is stated in the introduction, the publication of Eddington's posthumous papers in this form is a compromise between reprinting his drafts *in toto* and not publishing them at all. Not only would a full reprint have been economically forbidding; it would also have made access to Eddington's principal ideas even more difficult. From what has emerged, it looks as if Slater had proceeded with great dexterity and with a respect for his material and its author that does him credit.

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Microwave Principles. Herbert J. Reich, John G. Skalnik, Philip F. Ordung, Herbert L. Krauss. Van Nostrand, Princeton, N.J., 1957. ix + 427 pp. Illus. $8.75.

Microwave Principles is one of the volumes in the Van Nostrand series in electronics and communications, which is edited by the senior author. As the authors point out in the preface, this book is essentially an abridgment of *Microwave Theory and Technique* (1953), written by the same group of authors. It was apparently felt that an abridged version would be more suitable as a text for a one-semester course for senior-level students in the field of communications. The authors point out that this condensation was accomplished by eliminating the mathematical detail, which they feel belongs more appropriately in a more advanced book. They do feel, however, that adequate treatment of fundamental principles has not been sacrificed by this type of abridgment. Some new material has been added, although no attempt has been made to bring the book totally up to date.

At the outset, I would like to point out that I feel that this book is competently written and that it covers enough of the diverse aspects of the microwave field to be rewardingly informative and continuingly useful and of interest to engineers or physicists practicing in the microwave field. This is certainly a palatable presentation of the body of knowledge which must be encompassed by those hoping to practice effectively in the field. An opinion about the pedagogical effectiveness of this book is not as easily stated or even as easily arrived at.

I feel that the separation of the mathematical techniques from the multitude of detailed descriptions which must be given is, in fact, an advance in presentation. It seems rather unrealistic to attempt to teach details of application along with the mathematics of electromagnetic theory. There is plenty of material for a senior-level student to digest in this book without his having to learn analytical techniques also. In a sense, I feel that the handbook technique, which, essentially, is what is used here, is preferable in that it allows the material to be presented succinctly and in small space, thus giving the student a bird's-eye view of the field. By contrast, the multivolume series of books known as the *Radiation Laboratory Series* gives a presentation of microwave techniques. The two difficulties with the latter series lie in the fact that it is now out of date, by 12 years, and that it occupies too many volumes to be of value to the average microwave practitioner. It would seem, then, that when a considerable amount of detailed material is being presented, the concise "why," together with a fleeting "how," is a preferable presentation.

It should probably also be pointed out that the fact that *Microwave Principles* comes some 12 years after publication of the *Radiation Laboratory Series* is hardly, of itself, sufficient reason for its creation. Nor is the fact that it strives to be up to date (through the early months of 1957) a compelling reason for its consideration. On the contrary, the striking impression to be gained from reading *Microwave Principles* is that so little has changed in the intervening years. This is certainly to the credit of the book, for the writing of a text of this sort with the prime motive of introducing only the new and up-to-date material tends to create a book which has only transient significance. It is the generous amount of space given to basic, timeworn, and, for the most part, even unsophisticated material which will prevent this book from becoming rapidly obsolete.

I picked up my own acquaintanceship with microwave techniques in a thoroughly unorganized fashion — mainly from fundamental papers in the field— but it would be intellectually dishonest of me to say that my own experience was ideal. On the other hand, it would be equally shortsighted to say that the use of any one text, such as *Microwave Principles,* is a proper means of becoming acquainted with the microwave field. Most probably, to study both this text and the reference sources, and to expend much more time in such study than is possible for the average person, is the optimum way to be introduced to the field.

As I have said, the microwave field contains such a body of knowledge that a perfunctory recitation of what this book contains is of little use. Suffice it to say, it considers transmission lines and guides, components for manipulating the fields (such as bends, twists, T's and so forth), impedance matching and general microwave impedance measurements, antennas, resonators, and the sources of microwave power and their properties. Since this is a textbook, problems are presented at appropriate points in the text, and some appropriate laboratory experiments for demonstrating microwave properties and techniques are outlined in an appendix. There are numerous illustrations throughout the text in the form of clearly executed line drawings or photographs. The primary aim of the book is to be descriptive. Good illustrations are a prime necessity, and the ones in *Microwave Principles* undoubtedly increase the value of the book very greatly.

M. W. P. STRANDBERG
Research Laboratory of Electronics, Massachusetts Institute of Technology

Chemistry Creates a New World. Bernard Jaffe. Crowell, New York, 1957. xii + 321 pp. $4.50.

Bernard Jaffe is well known for his elementary chemistry texts, several of which have had wide circulation in secondary schools of this country. His present work is designed for a broader distribution. In the author's words, its aim is to meet "the widespread desire of alert and thoughtful people of all ages for a simple basic understanding of chemistry and its major achievements."

The book is interesting and easy to read and manages to get across many of the simpler chemical concepts in an outstandingly clear manner. The first three chapters present the basic facts, history, and theories of chemistry which are minimal for the understanding of modern developments. The eight chapters which follow outline the contribution of creative chemical technology to the material progress of our age. Included are accounts of the applications of chemistry in medicine, food production, and metallurgy; in the production of synthetic gasoline, rubber, and fibers; and in the release of atomic energy. A notable omission is a report on the high-energy fuels which are so significant to rocketry, a field with which the chemical industry

is perhaps more closely allied than it is with atomic energy.

There are some errors in the book (mainly resulting from attempts to oversimplify), such as in the definition of bases (page 42) and of atomic number (page 240). In some chapters the author diverges rather widely from his scientific theme, as in the long discussion of the post-World War II synthetic rubber controversy (page 198 *et seq.*). Some readers will share my antipathy to the breezy, *Time*-like phraseology prevalent in parts of the book—for example, the description of the eminent British physicist as "big burly effervescent Rutherford"!

Glenn T. Seaborg, in his introduction, points out the two-pronged social purpose of popularizations of science such as this book—the need to encourage young people into scientific careers and to enable the nonscientist citizen to make intelligent decisions concerning scientific developments. *Chemistry Creates a New World* is an honest attempt to satisfy these requirements and, despite the few shortcomings noted above, should prove to be of undoubted value to many nonscientist readers.

GORDON M. HARRIS
University of Buffalo

The Physiology of Reproduction in Fungi. Cambridge Monographs in Experimental Biology No. 6. Lilian E. Hawker. Cambridge University Press, New York, 1957. 128 pp. $3.

This book—a compact, well-organized, and lucid review of the widely-dispersed literature concerned with the physiological aspects of reproduction in fungi—is a fit companion to its predecessors in the series of Cambridge Monographs in Experimental Biology. Following introductory chapters describing the types of reproduction and the development of reproductive structures found in various groups of fungi, there is a short chapter on the physiology of vegetative reproduction. Two rather extensive chapters on the effect of environmental and nutritional factors on reproduction constitute the bulk of the book. These are followed by a chapter on the physiology of sex in fungi, which contains brief discussions of heterothallism, hormones, and sex determination. In addition to being a sort of summary, the last chapter, which deals with reproduction in the natural habitat, points out the practical importance of the physiology of reproduction to the industrial mycologist and plant pathologist.

The author—or, indeed, the reader—of a review of the literature must be spurred in his efforts by the hope that, from the myriad facts that he must sift, there will emerge generalizations of broad application and profound significance. Although there is as yet too little information on the physiology of reproduction in the fungi for this hope to be realized, Lilian Hawker's book makes two very worth-while contributions. First, by presenting the facts in all of their diversity and complexity, it should help to lay to rest some of the teleological oversimplifications which have crept into the folklore of biology under the guise of generalizations. Second, the book should do much to stimulate investigation in an interesting and important field, and it is to be hoped that, from the results of experiments thus stimulated, it will be possible to deduce valid generalizations in the future.

ROBERT M. PAGE
Stanford University

New Books

Gregor Mendel und das Schicksal Seiner Entdeckung. Ingo Krumbiegel. Wissenschaftliche, Stuttgart, Germany, 1957. 144 pp. DM. 10.80.

High-Speed Aerodynamics (Compressible Flow). Elie Carafoli. Translated from *Aerodinamica Vitezelor Mari,* Editura Academiei R.P.R., Bucharest. Pergamon Press, New York, 1957. 702 pp. $15.

1001 Questions Answered about the Weather. Frank H. Forrester. Dodd, Mead, New York, 1957. 432 pp. $6.

Ancient Man in North America. H. M. Wormington. Denver Museum of Natural History, Denver, ed. 4, 1957. 340 pp. Cloth, $5.25; paper, $3.65.

Science in Everyday Life. Ellsworth S. Obourn, Elwood D. Heiss, Gaylord C. Montgomery. 636 pp. $4.68.

Grain Boundaries in Metals. D. McLean. Oxford University Press, New York, 1957. 356 pp. $8.

Safety Aspects of Nuclear Reactors. C. Rogers McCullough, Ed. Van Nostrand, Princeton, N.J., 1957. 249 pp. $8.50.

Nuclear Energy in the South. Redding S. Sugg, Jr., Ed. Louisiana State University Press, Baton Rouge, 1957. 166 pp. $3.50.

Soviet Education for Science and Technology. Alexander G. Korol. Technology Press and Wiley, New York; Chapman & Hall, London, 1957. 538 pp. $8.50.

The Aphidoidea of the Middle East. F. S. Bodenheimer and E. Swirski. Weizmann Science Press, Jerusalem, 1957. 378 pp.

Source Books of Industrial Solvents. vol. II, *Halogenated Hydrocarbons.* Ibert Mellan. Reinhold, New York; Chapman & Hall, London, 1957. 267 pp. $7.

Principles of Electrical Measurements. H. Buckingham and E. M. Price. Philosophical Library, New York, 1957. 623 pp. $15.

An Introduction to Transistor Circuits. E. H. Cooke-Yarborough. Oliver and Boyd, London; Interscience, New York, 1957. 166 pp. $2.75.

A History of Nutrition. The sequence of ideas in nutrition investigations. Elmer Verner McCollum. Houghton, Mifflin, Boston, 1957. 461 pp. $6.

Dynamic Aspects of Biochemistry. Ernest Baldwin. Cambridge University Press, New York, ed. 3, 1957. 546 pp. $5.50.

Liver-Brain Relationships. Ian A. Brown. Thomas, Springfield, Ill., 1957. 211 pp.

The Life of Mammals. J. Z. Young. Oxford University Press, New York, 1957. 835 pp. $10.

Livestock Improvement in Relation to Heredity and Environment. J. E. Nichols. Oliver and Boyd, Edinburgh, Scotland, ed. 4, 1957. 251 pp. 16s.

Of Men and Marshes. Paul L. Errington. Macmillan, New York, 1957. 159 pp. $4.50.

Rice in India. Compiled by R. L. M. Ghose, M. B. Ghatge, V. Subrahmanyan. Indian Council of Agricultural Research, New Delhi, 1956. 517 pp. Rs. 21.

A Scientific Vocabulary for Beginning Zoology Students and Non-Scientific Students. Mary J. Brown. Pageant Press, New York, 1957. 104 pp. $3.

Particulate Clouds: Dusts, Smokes and Mists. Their physics and physical chemistry and industrial and environmental aspects. H. L. Green and W. R. Lane. Van Nostrand, Princeton, N.J., 1957. 444 pp. $11.25.

Analytical Conics. Barry Spain. Pergamon Press, New York and London, 1957. 152 pp. $5.

Rocket. Philip Joubert de la Ferte. Philosophical Library, New York, 1957. 190 pp. $6.

Research in Photosynthesis. Papers and discussions presented at the Gatlinburg Conference, 25–29 Oct. 1955, sponsored by the Committee on Photobiology of the National Academy of Sciences–National Research Council and supported by the National Science Foundation. H. Gaffron, C. S. French, R. Livingston, E. I. Rabinowitch, B. L. Strehler, N. E. Tolbert, Eds. Interscience, New York, 1957. 538 pp. $12.

Handbook of Magnesium-Organic Compounds. vol. I, *Reactions of Magnesium-Organic Compounds Nos. 1–7284*; vol. II, *Reactions of Magnesium-Organic Compounds Nos. 7285–13395.* vol. III, *Indexes of End-Products of Reactions, Magnesium-Organic Compounds, Authors and Co-Authors.* S. T. Yoffe and A. N. Nesmeyanov. Pergamon Press, London and New York, 1957. 2048 pp. $72.

The Proterozoic in Canada. Royal Society of Canada Special Publ. No. 2. James E. Gill, Ed. University of Toronto Press, Toronto, Canada, 1957. 201 pp. $5.95.

The Appraisal of Applicants to Medical Schools. Report of the Fourth Teaching Institute, Association of American Medical Colleges, Colorado Springs, Colorado, 7–10 Nov. 1956. Helen Hofer Gee and John T. Cowles, Eds. Association of American Medical Colleges, Evanston, Ill., 1957. 247 pp. $3.

Chemical Engineering in the Coal Industry. An international conference organized by the National Coal Board, Great Britain, June 1956. Forbes W. Sharpley. Pergamon Press, London and New York, 1957. 146 pp. $8.50.

Meetings and Societies

Roles for Senior Physiologists

Roles for senior physiologists was the topic discussed at a special session of the meeting of the American Physiological Society, held at the State University of Iowa, from 4 to 6 September. As chairman of the society's Committee on Placement of Senior Physiologists, I presided and reviewed recent events pertinent to the topic. Last January the other members of the committee joined me in seeking the advice of 175 senior members of the society. We asked them what forms of professional activity best utilize the capabilities of senior physiologists. The speakers at the special session dealt with some of the topics emphasized by the 82 members who responded to our inquiry.

Are there teaching opportunities in colleges for retired physiologists? E. A. Hewitt (Iowa State College) explored this question through an inquiry addressed to 24 Iowa colleges. While the majority of the 23 replies were unfavorable, six colleges opened the door to this possibility by expressing willingness to consider hiring retired physiologists for teaching or research. Horace W. Davenport, head of the department of physiology at the University of Michigan, discussed opportunities for professors to continue research after becoming professors emeritus. He described the practice at a few institutions and pointed out some of the difficulties "well-known to us all" that prevent establishment of a rigid policy.

Fred R. Griffith, Jr. (professor emeritus, University of Buffalo) had prepared a survey of retirement policies in medical schools. Griffith was unable to present his paper; in his absence his findings were presented by W. F. Hamilton. From 81 replies to 94 inquiries, the following facts emerged: 7 percent have no retirement plan or do not enforce one; 27 percent have retirement at age 70 or options making this mandatory; 16 percent have retirement at age 68 or options making this mandatory; 7 percent have retirement at age 67 or options making this mandatory; and 45 percent have retirement at age 65. Space and support are provided for those who desire them in many cases, although allocation of space may be left to the new head of the department, and support may depend on getting grants from outside sources. In some cases it is expected that the retired professor will move to another department. In a few cases neither space nor support is provided.

T. L. Patterson spoke on research opportunities in marine biological laboratories. For those retired physiologists who have suitable research interests, many such laboratories have ample unused research facilities for nine months of the year.

Until recently the U.S. State Department has had a science attaché at a few of the major embassies. W. H. Forbes, the last physiologist holding such an appointment, described what was expected of him. The job requires wide scientific knowledge, tolerance, understanding of human nature, ability to speak the language, scientific integrity, and ability to make friends. Forbes urged that a strong Washington office be set up by the State Department, that attachés be appointed for two years, and that there be two scientists at each of six or eight posts, with appointments staggered to give a one-year overlap.

It had been hoped that James A. Shannon (National Institutes of Health) would discuss opportunities offered senior scientists by the Government. In his telegram explaining his inability to attend he emphasized two points: (i) There is an established pattern in the Government, wherein senior scientists have served in the past, and will continue to serve, as senior scientific advisers. The number of these positions is limited, but the service these individuals render is invaluable. (ii) Public Health Service grant funds are available for support of senior scientists. As in the past, the Public Health Service will accept research grant applications from individuals beyond the age of formal retirement from their academic posts. The university concerned must support the application and provide adequate physical facilities for the program. Such a research grant can contain the salary of the principal investigator to the extent that the total salary derived from retirement income and the research grant is equivalent to that of a comparable full-time research worker.

Charles C. Chapple (U.S. Veterans Administration) expressed his interest in the session in a letter which read, in part: "Each Veterans Administration Hospital is autonomous in its selection of employees and consultants, and on this account interested individuals should apply directly to the manager of the hospital of his choice. Interested individuals can write the Assistant Chief Medical Director for Research and Education for information about the type of research going on in any particular hospital as a preliminary step if any would care to do so, or the applicant can, of course, learn this by calling personally on the hospital manager. There are research laboratories in all the hospitals affiliated with medical schools and in many of those which are not. The interests in these hospitals vary widely, but in many there is need for assistance in physiology, pharmacology, and biochemistry in particular."

Nearly 12,000 retired college and university faculty members are listed in a registry maintained by Constantine Panunzio. It includes many scientists, including a few physiologists. He has had good success in placing retired scientists, mathematicians, and engineers. His address is Dr. Constantine Panunzio, Director, Emeriti Employment Registry, Box 24451, Los Angeles 24, California.

The autumn, 1957, issue of the *AAUP Register* announces that there will soon be set up, in Washington, D.C., a registry of retired faculty members: "The Ford Foundation, on July 1, 1957, made a grant of $205,000 to the American Association of University Professors and the Association of American Colleges for the establishment and administration, during a five-year period, of a national register of retired college and university faculty members available for academic positions. The Council, in November 1955, had approved sponsorship of such a register by the American Association of University Professors (*Bulletin*, Vol. 42, p. 183), and the two Associations later submitted a joint proposal to the Fund for the Advancement of Education, established by the Ford Foundation, for such a register as a service to higher education in a time of growing need for faculty personnel."

The 82 physiologists who replied to our original inquiry made many penetrating and wise comments. The following paragraphs, quoted from A. N. Richards' reply, sum up the thoughts of many: "Provision for useful and satisfying post-retirement years for a scientist is a highly individual matter and can be settled satisfactorily only with a background of intimate knowledge of the human and scientific make-up of departments in

which he might hope to find productive happiness. It seems to be the almost universal aim of foundations, private and governmental, to discover and promote youthful promise. To discover and promote senescent ability and promise doesn't offer much allure. But, if young scientists, thoughtful about their long future, and obliged to witness their older models cast up on the beach, long before they have the privilege of dying, recruitment of some of the good young minds may meet interference.

"It seems to me that, connected with any of the three suggestions you have put forward, or the vague and probably unfeasible thoughts which I have tried to express, there must be escape clauses, admittedly difficult to implement or even visualize—escape for the man; escape for the institution."

Finally, President Louis Katz congratulated the members of the committee and the participants in the session. During his tour as president-elect, he said, many physiologists had expressed to him their appreciation of the activities of the committee; it has helped some physiologists and it has strengthened physiology.

D. B. DILL

Joppa, Maryland

Geriatrics Symposium

An informal symposium on problems of geriatrics will be held in New York, 31 January–1 February, under the auspices of the Institute of the Geriatric Institute of the Daughters of Jacob and Johns Hopkins University. The topics for discussion will be lipid metabolism, metabolic role of B_{12} analogues, and absorption of nutrients in general. For further information, communicate with Dr. Bacon F. Chow, Department of Biochemistry, School of Hygiene and Public Health, Johns Hopkins University, Baltimore 5, Md.

Vitamin B_{12} Symposium

A symposium on Vitamin B_{12} will be held on 11 April at the New York Medical College under the sponsorship of the Society for the Study of Blood. Those interested in taking part in the program should submit a manuscript or abstract to the secretary, Dr. Janet Watson, 451 Clarkson Ave., Brooklyn 3, N.Y.

College-Industry Conference

"New Concepts in the Education and Development of Technical Manpower" is the theme of the 1958 College–Industry Conference of the American Society for Engineering Education which will be held at the University of Michigan 30–31 January. Five speakers are scheduled to present the new concepts arising from current research, and four others will describe new programs designed by their companies to utilize new concepts of professional development. For information, write to Prof. William McIlvaine, College of Engineering, University of Michigan, Ann Arbor.

Society Elections

■ American Society for the Study of Arteriosclerosis: pres., R. Gordon Gould, Los Alamos, N.M.; vice pres., J. C. Paterson, London, Ont., Canada; sec-treas., O. J. Pollak, Dover, Del.

■ Institute of the Aeronautical Sciences: pres., Edward C. Wells, Boeing Airplane Co. The vice presidents are: B. W. Chidlaw, Neil Burgess, L. Eugene Root, and H. Guyford Stever; treas., R. Dixon Speas; sec., Robert R. Dexter.

■ New York Academy of Sciences: pres., Boris Pregel, Canadian Radium and Uranium Corp.; pres.-elect, Hilary Koprowski, University of Pennsylvania. The vice presidents are M. J. Kopac, New York University Graduate School, and Cornelius P. Rhoads, Memorial Center for Cancer and Allied Diseases; cor. sec., Frederick C. Nachod, Sterling-Winthrop Research Institute; rec. sec., Emerson Day, Strang Memorial Clinic for Cancer Research; treas., Robert F. Light, Standard Brands, Inc.

■ Society of American Foresters: pres., George A. Garratt, Yale University; vice pres., Henry J. Malsberger, Southern Pulpwood Conservation Society.

■ New Jersey Academy of Science: pres., Robert K. Zuck, Drew University; 1st vice pres., James H. Weathem, State University of New Jersey; 2nd vice pres., M. Lelyn Branin, Newark College of Engineering; sec., Hirsch L. Silverman, Nutley Public Schools; treas., Courtlandt J. Daley, Cranford Senior High School.

Forthcoming Events

January

30–31. Mathematical Assoc. of America, annual, Cincinnati, Ohio. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

30–1. American Assoc. of Physics Teachers, New York. (F. Verbrugge, Univ. of Minnesota, Minneapolis.)

30–1. Western Soc. for Clinical Research, 11th annual, Carmel-by-the-Sea, Calif. (A. J. Seaman, Univ. of Oregon Medical School, Portland 1.)

31–1. Problems of Geriatrics, symp. (by invitation only), New York. (B. F. Chow, Johns Hopkins Univ., School of Hygiene and Public Health, 615 N. Wolfe St., Baltimore 5, Md.)

February

1–14. Pan American Assoc. of Ophthalmology, Caribbean cruise cong., sailing from New York, N.Y. (L. V. Arnold, 33 Washington Sq. W., New York 11.)

3–4. Progress and Trends in Chemical and Petroleum Instrumentation, Wilmington, Del. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

3–7. American Inst. of Electrical Engineers, winter genl., New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

5–7. Biophysical Soc., Cambridge, Mass. (A. K. Solomon, Biophysical Lab., Harvard Medical School, Boston, Mass.)

10–14. American Soc. for Testing Materials, St. Louis, Mo. (F. F. Van Atta, ASTM, 1916 Race St., Philadelphia 3, Pa.)

13–15. National Soc. of Professional Engineers, spring, East Lansing, Mich. (NSPE, 2029 K St., NW, Washington 6.)

16–20. American Inst. of Mining, Metallurgical and Petroleum Engineers, annual, New York. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

20–21. Transistor and Solid State Circuits Conf., Philadelphia, Pa. (J. H. Milligan, Jr., Dept. of Electrical Engr., New York Univ., New York 53.)

22–25. American Educational Research Assoc., St. Louis, Mo. (F. W. Hubbard, AERA, 1201 16th St., NW, Washington 6.)

24–28. American Soc. of Civil Engineers, Chicago, Ill. (W. W. Wisely, ASCE, 33 W. 39 St., New York 18.)

March

1. Junior Solar Symposium, Tempe, Ariz. (Association for Applied Solar Energy, 3424 N. Central Ave., Phoenix, Ariz.)

1–3. National Wildlife Federation, St. Louis, Mo. (E. F. Swift, NWF, 232 Carroll St., NW, Washington 12.)

3. Wildlife Soc., annual, St. Louis, Mo. (D. L. Leedy, U.S. Fish and Wildlife Service, Washington 25.)

5–6. Gas Conditioning Conf., 7th annual, Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

6–8. Fundamental Cancer Research, 12th annual, Houston, Tex. (W. K. Sinclair, M. D. Anderson Hospital and Tumor Inst., Univ. of Texas, Houston 25.)

6–8. Optical Soc. of America, annual, New York. (A. C. Hardy, Massachusetts Inst. of Technology, Cambridge 39.)

10–13. American Assoc. of Petroleum Geologists, annual, Los Angeles, Calif. (R. H. Dott, AAPG, Box 979, Tulsa 1, Okla.)

10–13. Society of Economic Paleontologists and Mineralogists, annual, Los Angeles, Calif. (R. H. Dott, Box 979, Tulsa, Okla.)

16–21. Nuclear Engineering and Sci-

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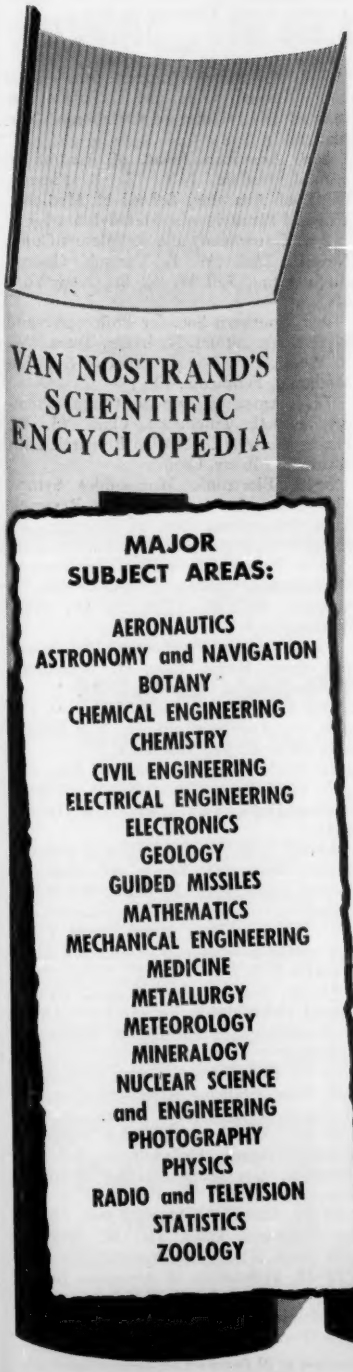

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17–21. National Assoc. of Corrosion Engineers, 14th annual, San Francisco, Calif. (NACE, Southern Standard Bldg., Houston 2, Tex.)

18–20. Amino Acids and Peptides, Ciba Foundation symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

20–22. Michigan Acad. of Science, Arts and Letters, annual, Ann Arbor, (R. F. Haugh, Dept. of English, Univ. of Michigan, Ann Arbor.)

20–22. Pulmonary Circulation Conf., Chicago, Ill. (Wright Adams, Chicago Heart Assoc., 69 W. Washington St., Chicago 2.)

20–23. International Assoc. for Dental Research, annual, Detroit, Mich. (D. Y. Burrill, Univ. of Louisville, School of Dentistry, 129 E. Broadway, Louisville 2, Ky.)

23–26. American Assoc. of Dental Schools, annual, Detroit, Mich. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

23–29. American Soc. of Photogrammetry, 24th annual, jointly with American Cong. on Surveying and Mapping, 18th annual, Washington, D.C. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

24–27. Institute of Radio Engineers, natl. conv., New York. (G. W. Bailey, IRE, 1 E. 79 St., New York 21.)

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27–29. National Science Teachers Assoc., 6th natl., Denver, Colo. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

29. South Carolina Acad. of Science, annual, Charleston. (Miss M. Hess, Dept. of Biology, Winthrop College, Clemson, S.C.)

29–30. American Psychosomatic Soc., 15th annual, Cincinnati, Ohio. (T. Lidz, 551 Madison Ave., New York 22.)

30–3. American College Personnel Assoc., annual, St. Louis, Mo. (L. Riggs, DePauw Univ., Greencastle, Ind.)

April

1–3. Corrosion Control, 5th annual conf., Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

2–4. American Assoc. of Anatomists, annual, Buffalo, N.Y. (L. B. Flexner, Dept. of Anatomy, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)

2–4. Instruments and Regulators Conf., Newark, Del. (W. E. Vannah, Control Engineering, 330 W. 42 St., New York 36.)

4–5. Southern Soc. for Philosophy and Psychology, annual, Nashville, Tenn. (W. B. Webb, U.S. Naval School of Aviation Medicine, Pensacola, Fla.)

7–11. American Assoc. of Cereal Chemists, annual, Cincinnati, Ohio. (J. W. Pence, Western Utilization Research Laboratories, Albany, Calif.)

8–10. Electronic Waveguides Symp., New York. (J. Fox, Microwave Research Inst., Polytechnic Inst. of Brooklyn, 55 Johnson St., Brooklyn 1, N.Y.)

9–12. National Council of Teachers of Mathematics, Cleveland, Ohio. (M. H. Ahrendt, NCTM, 1201 16 St., NW, Washington 6.)

9–14. Applied Psychology, 13th internatl. cong., Rome, Italy. (L. Meschieri, National Inst. of Psychology, Rome.)

10–11. American Inst. of Chemists, annual, Los Angeles, Calif. (L. Van Doren, AIC, 60 E. 42 St., New York 17.)

10–12. National Speleological Soc., annual, Gatlinburg, Tenn. (G. W. Moore, Geology Dept., Yale Univ., New Haven, Conn.)

10–12. Ohio Acad. of Science, annual, Akron, Ohio. (G. W. Burns, Dept. of Botany, Ohio Wesleyan Univ., Delaware, Ohio.)

11. Vitamin B-12 Symp., New York, N.Y. (Miss J. Watson, 451 Clarkson Ave., Brooklyn 3, N.Y.)

11–12. Eastern Psychological Assoc., annual, Philadelphia, Pa. (G. Lane, Dept. of Psychology, University of Delaware, Newark.)

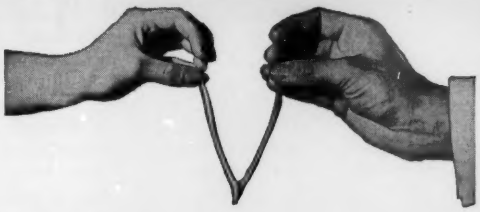
11–18. Horticultural Cong., 15th internatl., Nice, France. (Secretariat General, 84, rue de Grenelle, Paris 7e, France.)

13–14. American Soc. for Artificial Internal Organs, Philadelphia, Pa. (G. Schreiner, Georgetown Univ. Hospital, Washington 7.)

13–18. American Chemical Soc., 133rd, San Francisco, Calif. (R. M. Warren, ACS, 1155 16 St., NW, Washington 6.)

13–19. Federation of American Societies for Experimental Biology, annual, Philadelphia, Pa. (M. O. Lee, FASEB, 9650 Wisconsin Ave., Bethesda 14, Md.)

(*See issue of 20 December for comprehensive list*)



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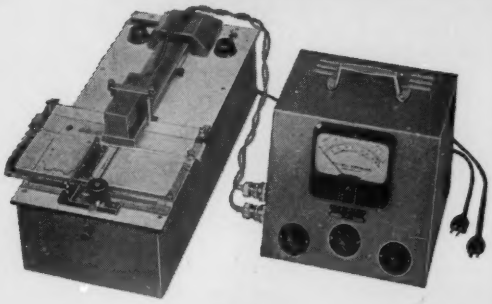

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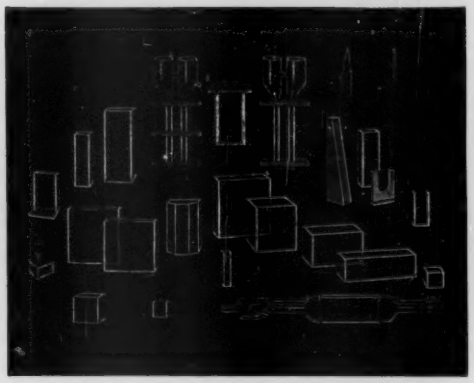

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■ FREQUENCY CONVERTER furnishes 75 w of 1200- or 2400-cy/sec power. Input power is 95 w at 400 cy/sec, three-phase. Frequency multiplication of the 400-cy input provides synchronization of the output wave. The device is transistorized for compactness and lightness. Weight is 2.5 lb. Regulation is 3 percent from no load to full load. Rise time is 5 μsec. (Robertshaw-Fulton Controls Co., Dept. S818)

■ INTEGRATOR for gas and vapor-phase chromatography is available as part of original equipment or for use with a separate recorder. Integration is performed electrically. Indication is made by means of pen strokes at the margin of the chart. Three line lengths indicate units, tens, and hundreds. At full-scale deflection, 40 lines are recorded per second. (Burrell Corporation, Dept. S826)

■ AMPLIFIER SYSTEM is a seven-channel a-c voltage preamplifier for piezoelectric transducers. Voltage gains are 1.0 and 10.0. Input impedance is 100 megohm with bandwidth 0.4 to 200,000 cy/sec. Each channel has its own isolated power supply. (Dynamics Instrumentation Co., Dept. S833)

■ FLOW SWITCH will detect flows in the range from ¼ to ½ gal/min and provide circuit closure for indication or control. The transducer will operate in any attitude. Normal temperature operating range is $-85°$ to $+550°$F. Reverse flow can also be detected. The instrument is supplied in aluminum, stainless steel, bronze, nickel, Monel, Inconel, or other metals. (Potter Aeronautical Corp., Dept. S839)

■ WATER DETECTOR for crude oil can be used also to detect and control other constituents which affect the dielectric constant of a process material. The fixed dielectric-constant capacitor probe is sensitive to variations of 0.1 percent. Water content is indicated by pilot lights, and signals are transmitted to a control unit which actuates valves to reroute contaminated material. Time delays may be set so that momentary variations are ignored. (Instruments, Inc., Dept. S830)

■ IONIZATION GAGE of the Bayard-Alpert type is linear through a range from 5×10^{-4} to 10^{-12} mm-Hg. A double filament is used for long tube life, and the grid can be outgassed by electron bombardment. The collector, a single wire enclosed in a spiral grid, is small enough to be outgassed by radiant heat. The Nonex-glass envelope has a half-inch-diameter tubulation provided with a graded Nonex-to-Pyrex seal. (Consolidated Electrodynamics Corp., Dept. S832)

■ KERR-CELL SHUTTER, designed to be mounted on a camera, has an aperture 1.25 by 2.0 in. Speeds are as great as 0.1 μsec, and triggering can be synchronized to within 2 mμ-sec. Electronic controls are contained in a modulator unit which can be remotely located and connected by flexible leads. The triggering pulse can be as low as 50 v. (Electro-Optical Instruments, Inc., Dept. S829)

■ RANDOM-SIGNAL VOLTMETER provides root-mean-square measurements of random voltage signals. Accurate long-time-average measurements are made in the presence of low-frequency components. A panel switch selects a 0.1-sec integration time for quick estimates or a 10-sec interval for exact measurement. Accuracy is ±2 percent on 18 full-scale ranges from 500 μv to 250 kv r.m.s. Bandwidth is 2 to 250,000 cy/sec within ±0.2 db. (Flow Corporation, Dept. S836)

■ ACTIVATED CARBON is available in molded shapes formed from powdered, highly adsorbent carbon bonded with an organic resin. The shapes are treated to be dust free. Two sizes of wafers are presently standard; one 3 mm thick by 33 mm in diameter, the other 9 by 38 mm. (National Carbon Company, Dept. S831)

■ VIBRATOR employs a hydraulic-mechanical system to produce forces up to 20,000 lb at frequencies up to 600 cy/sec. Acceleration levels up to 50 *g* are reached. The vibrator consists of a vibration head, a hydraulic pump unit, and a variable-speed-drive motor. The force piston is designed to carry loads up to 100 lb directly. Larger loads are independently suspended. (L. A. Corporation, Dept. S843)

■ TIME-CODE GENERATOR supplies a 16-bit, 24-hour binary code to hours, minutes, and seconds. Time can be read directly to 0.01 sec and interpolated to 0.001 sec. In addition to binary codes, continuous pulse trains of 100, 10, and 5 pulses/sec are produced. The time source is a temperature-controlled crystal with long-term accuracy of 1 in 10^6. Coding is done by transistor-driven magnetic cores.

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■ HIGH-VOLTAGE POWER SUPPLY for scintillation counters uses a bank of 17 cold-cathode tubes to regulate the output voltage. Drift over a 6-day period is less than 1/1000. Output voltage is variable in 17 steps from 100 to 1400 v; output current is 1 ma. Load regulation is 0.35 percent, and line regulation is 0.01 percent from 100 to 130 v. (Victoreen Instrument Co., Dept. S804)

■ INFRARED ANALYZER, for gases of medical interest, uses detector cells sensitive to the gas to be measured. Cells can be interchanged to permit measurement of carbon dioxide, nitrous oxide, cyclopropane, Fluothane, and other gases. Application to anesthesia monitoring is suggested. (Spinco Division, Beckman Instruments, Inc., Dept. S835)

■ VARIABLE-FREQUENCY OSCILLATOR has a continuously adjustable range of 100 cy to 100 kcy/sec. Output frequency is selected by positioning five digital selector switches. Accuracy is ±0.005 percent or ±5 counts, whichever is greater. A crystal-controlled generator is used as a reference-signal source. (Digital Instrument Laboratories, Dept. S838)

■ VOLATIMETER is an instrument for determining the moisture content of solids. Water vapor volatilized from the particles of the specimen just below the melting point is trapped in a syringe of the apparatus. Rise of the syringe piston measures the volume of vapor thus collected. (Manufacturers Engineering and Equipment Corporation, Dept. S842)

■ ELECTROMAGNETIC ANGLE TRANSDUCER, developed by Bell Telephone Laboratories under Air Force contract, exhibits resolution better than ±3 sec of arc. The instrument is a reluctance-type, variable-coupling transformer. Two output voltages vary in amplitude as the sine and cosine of 27 times the angle through which the rotor is turned. Other ratios are possible. All windings are on the stator, leaving the rotor free of sliding contacts. (Clifton Precision Products Co., Dept. S846)

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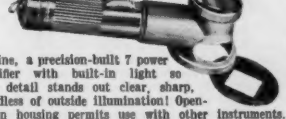

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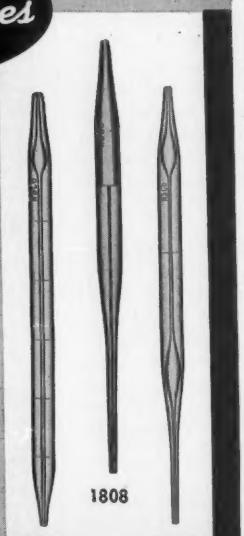

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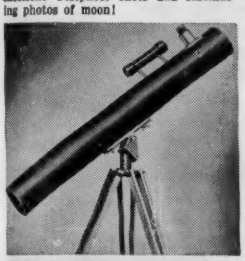

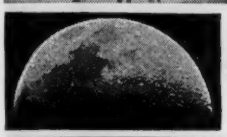

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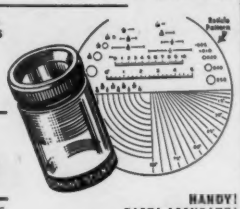

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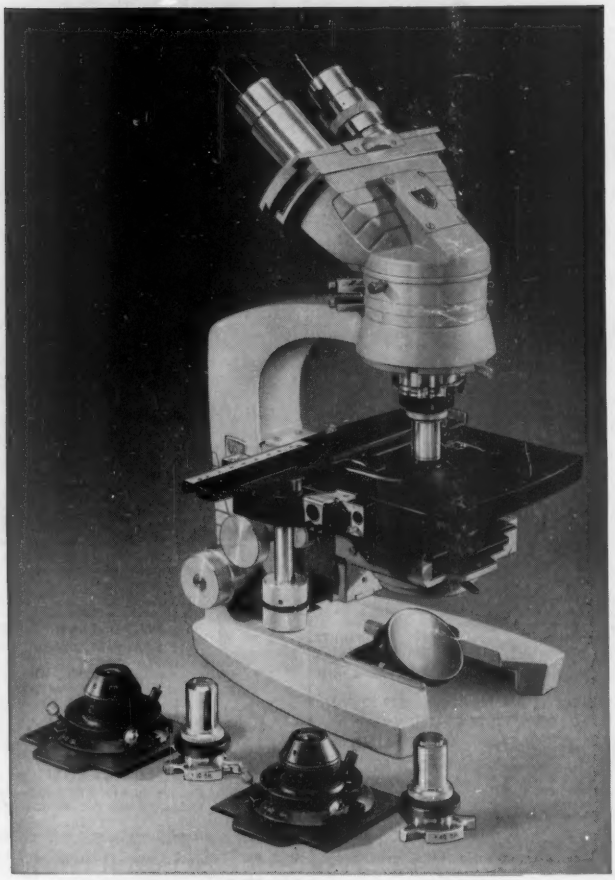

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